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TECHNICAL MANUAL

COAST ARTILLERY GUNNERS' INSTRUCTION FIXED SEACOAST ARTILLERY FIRST AND SECOND CLASS GUNNERS

April 10, 1942

TECHNICAL MANUAL No. 4-305

WAR DEPARTMENT, WASHINGTON, April 10, 1942.

COAST ARTILLERY GUNNERS' INSTRUCTION, FIXED SEACOAST ARTILLERY, FIRST AND SECOND CLASS GUNNERS

CHAPTER 1

GENERAL

1. Purpose and scope.—*a. Purpose.*—This manual is designed primarily for use by organization commanders in the instruction of enlisted men of fixed seacoast artillery units of the Coast Artillery Corps. It may be used also by officers conducting examinations of enlisted men for qualification as gunners, as contemplated by FM 4-150. The questions and answers are intended merely as a guide and should be supplemented by the extensive use of other questions and answers and by practical demonstrations.

b. Scope.—The topics included are those prescribed in FM 4-150 for qualification of enlisted men as first and second class gunners in the units indicated in *a* above.

2. Assignment of topics.—The following is the general assignment of topics. Each organization should omit those portions of the assigned chapters, sections, and paragraphs that do not pertain to the particular equipment in use by the organization.

SECOND CLASS GUNNERS

Subject	3-inch barbette carriage gun batteries	6-inch barbette carriage gun batteries	6-inch disappearing carriage gun batteries	10-inch disappearing carriage gun batteries	12-inch and 14-inch disappearing carriage gun batteries
Service of the piece	Secs. I and II, ch. 2.	Secs. I and III, ch. 2.	Secs. I and IV, ch. 2.	Secs. I and V, ch. 2.	Secs. I and VI, ch. 2.
Nomenclature of the various parts of the gun and carriage.	Sec. I, ch. 3.	Sec. I, ch. 3.	Sec. I, ch. 3.	Sec. I, ch. 3.	Sec. I, ch. 3.
Action, care, and minor adjustment of the various parts of the gun and carriage.	Pars. 26 and 29.	Pars. 26 and 29.	Pars. 26 and 27.	Pars. 26 and 27.	Pars. 26 and 27.
Powders, projectiles, primers, and fuzes, to include precautions in handling.	Ch. 7.	Ch. 7.	Ch. 7.	Ch. 7.	Ch. 7.
Cordage and mechanical maneuvers	Sec. III, ch. 13.	Sec. III, ch. 13.	Sec. III, ch. 13.	Sec. III, ch. 13.	Sec. III, ch. 13.
Nomenclature, action, and maintenance of the small arms with which the organization is equipped and its ammunition.	Sec. I, ch. 13.	Sec. I, ch. 13.	Sec. I, ch. 13.	Sec. I, ch. 13.	Sec. I, ch. 13.

Subject	12-inch mortar batteries	12-inch barbette carriage gun batteries	16-inch gun and howitzer batteries	Headquarters batteries, harbor defense units (except searchlight and supply platoon)	Supply platoon, headquarters batteries, harbor defense regiments and separate battalions
Service of the piece	Secs. I and VIII, ch. 2.	Secs. I and VII, ch. 2.	Secs. I and IX, ch. 2.	Same as for one of firing batteries.	Same as for one of firing batteries.
Nomenclature of the various parts of the gun and carriage.	Sec. I, ch. 3.	Sec. I, ch. 3.	Sec. I, ch. 3.	Sec. I, ch. 3.	Sec. I, ch. 3.
Action, care, and minor adjustment of the various parts of the gun and carriage.	Pars. 26 and 28.	Pars. 26 and 29.	Pars. 26 and 29.	Par. 26 and par. 27, 28, or 29, as prescribed.	Par. 26, and par. 27, 28, or 29, as prescribed.
Powders, projectiles, primers, and fuzes, to include precautions in handling.	Ch. 7.	Ch. 7.	Ch. 7.	Ch. 7.	Ch. 7.
Cordage and mechanical maneuvers	Sec. III, ch. 13.	Sec. III, ch. 13.	Sec. III, ch. 13.	Sec. III, ch. 13.	Sec. III, ch. 13.
Nomenclature, action, and maintenance of the small arms with which the organization is equipped and its ammunition.	Sec. I, ch. 13.	Sec. I, ch. 13.	Sec. I, ch. 13.	Sec. I, ch. 13.	Sec. I, ch. 13.
Motor transportation					Pars. 90 and 91.
Supplies					Ch. 12.

SECOND CLASS GUNNERS—Continued

Subject	Searchlight batteries, harbor defense regiments (except AA searchlight matériel); and searchlight platoon, headquarters batteries, harbor defense separate battalions	AA searchlight platoon, harbor defense regiments
Cordage and mechanical maneuvers.	Sec. III, ch. 13.	Sec. III, ch. 13.
Nomenclature, action, and maintenance of the small arms with which the organization is equipped, and its ammunition.	Sec. I, ch. 13.	Sec. I, ch. 13.
Motor transportation		Pars. 90 and 91.
Drill of the searchlight section	Sec. II, ch. 8.	Sec. I, ch. 8.
Nomenclature of the searchlight	Sec. V, ch. 8.	Sec. III, ch. 8.
Nomenclature of sound locator apparatus.		Sec. IV, ch. 8.
Nomenclature of the seacoast searchlight control system.	Sec. VI, ch. 8.	

FIRST CLASS GUNNERS

Subject	Gun batteries	Headquarters batteries, harbor defense units (except searchlight and supply platoon)	Supply platoon, headquarters batteries, harbor defense regiments and separate battalions	Searchlight batteries, harbor defense regiments (except AA searchlight matériel and searchlight platoon, headquarters batteries, harbor defense, separate battalions	AA searchlight platoon, harbor defense regiments
Duties of the range section.	Ch. 4.				
Use, orientation, and adjustment of observation instruments.	Ch. 5.	Ch. 5.		Ch. 5.	
Pointing methods and instruments.	Ch. 6.				
Use and care of telephones.	Sec. II, ch. 11.	Sec. II, ch. 11.	Sec. II, ch. 11.	Sec. I or II, ch. 11.	Sec. I, ch. 11.
Nomenclature, action, service, and drill of the antiaircraft machine gun; its mount, ammunition, and targets.	Sec. II, ch. 13.	Sec. II, ch. 13.			
Elementary definitions for seacoast artillery.	Sec. I, ch. 10.	Sec. I, ch. 10.	Sec. I, ch. 10.	Sec. I, ch. 10.	
Particular definitions pertaining to supplies and supply functions.			Sec. III, ch. 10.		

FIRST CLASS GUNNERS—Continued

Subject	Gun batteries	Headquarters batteries, harbor defense units (except searchlight and supply platoon)	Supply platoon, headquarters batteries, harbor defense regiments and separate battalions	Searchlight batteries, harbor defense regiments (except AA searchlight matériel; and searchlight platoon, headquarters batteries, harbor defense, separate battalions	AA searchlight platoon, harbor defense regiments
Indication, identification, and characteristic features of warships.	Sec. IV, ch. 13.	Sec. IV, ch. 13.	Sec. IV, ch. 13.	Sec. IV, ch. 13.	
Indication, identification, and characteristic features of aircraft.					Sec. V, ch. 13.
Elementary definitions for AA artillery.					Sec. II, ch. 10.
Motor transportation			Pars. 92 to 96, incl.		Pars. 92 to 95, incl.
Map reading			Sec. VI, ch. 13.		

Subject	Headquarters batteries, harbor defense units (except searchlight and supply platoon)	Supply platoon, headquarters batteries, harbor defense regiments and separate battalions	Searchlight batteries, harbor defense regiments (except AA searchlight matériel); and searchlight platoon, headquarters batteries, harbor defense separate battalions	AA searchlight platoon, harbor defense regiments
Care and operation of the searchlight power plant.			Sec. VIII, ch. 8.	Sec. VII, ch. 8.
Care and operation of the searchlight			Sec. XI, ch. 8.	Sec. IX, ch. 8.
Care and operation of the sound locator apparatus.				Sec. X, ch. 8.
Care and operation of the seacoast searchlight control system.			Sec. XII, ch. 8.	
Duties of an assistant in the care, operation, and maintenance of 25 kw sets.	Par. 75.			
General knowledge of the installation and operation of the harbor defense telephone system and net, to include duties of switchboard operators.	Sec. III, ch. 11.			
Radio communication	*Sec. IV, ch. 11.			

*Substituted for preceding subject in appropriate cases.

CHAPTER 2

SERVICE OF THE PIECE*

SECTION I

GENERAL

3. Organization of gun section.—*Q*. What is the manning detail for a gun emplacement? *A*. It is the gun section, consisting of a chief of section, a gun squad, and an ammunition squad.

Q. What is the manning detail for a mortar pit? *A*. It is the gun section, consisting of a pit commander, two mortar squads, an ammunition squad, and two display board operators.

Q. What are the strengths of the gun sections for various types of fixed armament? *A*.

Gun	Total of gun section	Numbered personnel in gun or mortar squad	Cannoneers in ammunition squad
3-inch, rapid fire	15	3	8
6-inch, pedestal mount	27	9	10
6-inch, disappearing carriage	28	10	10
10-inch, disappearing carriage	43	17	17
12-inch, barbette carriage	48	20	18
12-inch, disappearing carriage	51	22	19
12-inch, mortar	57	12	19
14-inch, disappearing carriage	51	22	19
16-inch gun and howitzer	42	11	20

*The service of the piece as given in this chapter is intended only as a guide in the assignment of individuals and duties.

Q. What is the organization of the gun squad? *A.* The gun commander (who is also the chief of section in the case of 10-inch or smaller-calibered guns), the gun pointer, the range setter, the chief of breech (in the case of 10-inch or larger-calibered guns), two display board operators (except for 3-inch gun), two recorders (except for 3-inch gun), and the cannoneers numbered consecutively from 1. In the case of the 16-inch gun and howitzer there is also one air-pressure operator.

Q. What is the organization of the mortar squad? *A.* The chief of squad, an azimuth setter, an elevation setter, an azimuth recorder, an elevation recorder, and the 12 cannoneers numbered 1 to 12, inclusive.

Q. What is the organization of the ammunition squad? *A.* A chief of ammunition and the prescribed number of cannoneers, numbered consecutively starting with the first number after those used for the gun or mortar squad. The squad is divided by its chief into details for the service of powder and projectiles.

Q. What is the formation of the gun section? *A.* Each section assembles in two ranks with 4 inches between files and 40 inches between ranks. The post of the chief of section (or gun commander) is in the front rank, 1 pace to the right of his section. The artillery mechanics take post in the front rank on the left of the gun sections to which they have been assigned.

NOTE.—The artillery mechanics are not members of the gun sections. They are assigned to these sections merely for the purposes of formation.

4. Duties of personnel.—*Q.* What are the duties of the chief of section (or pit commander)? *A.*

(1) The chief of section (noncommissioned officer) is in command of a gun section. He is responsible to the officer in charge of the emplacement for the—

(*a*) Training and efficiency of the personnel of his section.

(*b*) Condition of the matériel and ammunition under his charge.

(*c*) Camouflage discipline and gas discipline at the emplacement and magazines.

(*d*) Observance of all safety precautions pertaining to the service of the piece at his emplacement and magazines under his charge.

(*e*) Police of the emplacement and magazines under his charge.

(2) He supervises the service of the piece and the service of ammunition at his emplacement. He personally directs the work of care and preservation of matériel.

(3) When his section arrives at the emplacement he commands: 1. DETAILS, 2. POSTS, and supervises the procuring of equipment.

After all details have reached their posts he commands: EXAMINE GUN. He then personally makes an inspection of the gun, carriage, and other matériel, including that pertaining to the service of ammunition.

(4) He receives the reports of the gun commander and the chief of ammunition and reports to the officer in charge of his emplacement, "Sir, No. —— in order," or any defects he is unable to remedy without delay.

(5) When necessary to verify the section he commands: CALL OFF. The cannoneers of his section call off their titles or numbers, beginning with the unnumbered members, followed by the numbered members in order.

(6) He informs the chief of ammunition as to the projectile, fuze, and powder charge to be used.

(7) At the command TARGET he repeats the command and target designation. As soon as the gun pointer is on the target he reports to the officer in charge of the emplacement, "Sir, No. —— on target."

(8) At the command LOAD he repeats the command and supervises the loading. After the piece is loaded and pointed, he sees that all personnel are clear and then calls, "No. —— ready." The piece is not fired until the command COMMENCE FIRING has been given and the proper firing signal received.

(9) At the command COMMENCE FIRING, if the piece is unloaded, he commands: LOAD, and supervises the work of his section. He commands: LOAD, before each shot of a series. Upon receipt of the firing signal, he commands: 1. NO. ——, 2. FIRE, unless this duty is performed by the gun commander.

(10) When the number of shots to be fired has been designated, he commands: CEASE FIRING, when the specified number of shots has been fired. In any case he repeats the command CEASE FIRING when it is given by the battery commander. At the conclusion of a series of shots, he reports to the officer in charge of the emplacement, "Sir, No. —— (so many) rounds fired."

(11) During firing he stations himself in such a position as best to observe the functioning of the gun squad and the gun. He pays particular attention to the action of the gun in recoil and counterrecoil in order that a loss of oil by leakage may be immediately corrected.

(12) In case of a misfire he reports to the officer in charge of his emplacement, "No. —— misfire," and sees that the prescribed safety precautions are observed.

(13) He keeps a record of the number of rounds fired by his gun, showing the date and approximate time in order that the emplacement book may be kept posted accurately and up to date.

(14) At the command REPLACE EQUIPMENT he supervises the replacing of all equipment, sees that all matériel and ammunition are properly secured, and that the emplacement and magazines are properly policed. Then, unless otherwise directed, he forms his section.

Q. What are the duties of the gun commander? *A*.

(1) The gun commander (noncommissioned officer) is in command of a gun squad. If no chief of section is designated the gun commander will, in addition to his other duties, perform the duties prescribed for the chief of section. He is responsible to the chief of section for the—

(*a*) Efficiency of the personnel of his squad.

(*b*) Condition of the matériel under his charge.

(*c*) Observance of all safety precautions pertaining to the service of the piece.

(*d*) Police of the emplacement to which assigned.

(2) At the command EXAMINE GUN given by the chief of section he personally makes an inspection of the gun, carriage, and other matériel, paying special attention to the recoil cylinders, firing mechanism, safety devices, and the oiling of all movable parts. He also gives special attention to those parts most likely to cause trouble and to which special attention is directed by the pertinent Field Manuals and Technical Manuals.

(3) He receives the reports of the chiefs of the various details of the gun squad and reports to the chief of section, "No. —— in order," or any defects he is unable to remedy without delay.

(4) At the command LOAD he supervises the work of his squad.

(5) At the command TRIP (disappearing carriages) he supervises the tripping of the gun and sees that it goes fully into battery.

(6) In case II firing, after receiving the report "Range set" from the range setter, the piece being ready to fire, the gun commander calls and signals "No. —— ready," indicating to the gun pointer that the piece is ready to fire.

(7) In case III firing, after receiving the reports "Range set" and "Azimuth set" from the range setter and the azimuth setter, respectively, the piece being ready to fire, he calls and signals "No. —— ready," indicating that the piece is ready to fire. At the sounding of the proper time-interval signal, if he has been designated to fire the piece, he commands and signals: 1. NO. ——, 2. FIRE. He is re-

sponsible to the chief of section that the piece is fired immediately upon the proper signal.

(8) He commands: RELAY, in case the time-interval signal fails to sound at the gun or in case his gun is not ready to fire. He repeats the command RELAY when it is given by the chief of section.

(9) In case of a misfire he calls "No. —— misfire" and sees that the prescribed safety precautions are observed.

(10) At the command CEASE FIRING, when dummy ammunition is used, he sees that the piece is unloaded.

(11) At the command REPLACE EQUIPMENT the gun commander supervises the replacing of equipment, sees that all matériel is properly secured, and then, unless otherwise directed, forms his squad and reports to the chief of section.

Q. What are the duties of the chief of ammunition? *A*.

(1) The chief of ammunition (noncommissioned officer) is responsible to the chief of section for the efficiency of the personnel of his squad, for the care of the ammunition and ammunition handling apparatus, for the uninterrupted service of ammunition, for the observance of all safety precautions in the care and service of ammunition, and for the police of the magazines and galleries under his charge.

(2) He keeps a record of all ammunition received into and delivered from the magazines and galleries under his charge, exercising particular care that the projectiles, fuzes, and powder charges are listed under proper name and type. He keeps the chief of section informed regarding the ammunition on hand and reports any defects found.

(3) At the comand DETAILS, POSTS the chief of ammunition opens the galleries (and magazines if necessary) and posts the members of his squad.

(4) At the command EXAMINE GUN he inspects the matériel under his charge, gives the necessary instructions for preparing ammunition and equipment for drill or firing, and reports to the chief of section "Ammunition service in order" or any defects that he is unable to remedy without delay.

(5) At the command LOAD he directs and supervises the service of ammunition.

(6) At the command CEASE FIRING, when dummy ammunition is used, he causes the dummy projectiles and dummy powder charges to be put in their proper place in the gallery.

(7) At the command REPLACE EQUIPMENT he supervises the replacing of equipment, sees that all ammunition and other matériel are properly secured, forms his squad, and reports to the chief of section.

Q. Describe the duties performed by the ammunition squad. *A*. The chief of ammunition divides the cannoneers of the ammunition squad into two details, the projectile detail and the powder detail. The size of the two details depends on local conditions and is determined by the battery commander.

(1) *Projectile detail.*—The chief of ammunition designates one of the cannoneers as chief of detail who supervises the work of the detail. Previous to and during firing, the detail places projectiles on the delivery tables, loads them on shot trucks, runs the loaded trucks to the emplacement, turns them over to the track detail, and receives the empty trucks to be reloaded. In addition the detail maintains the ammunition and ammunition handling apparatus and polices the magazines and corridors.

(2) *Powder detail.*—The chief of ammunition designates one of the cannoneers as chief of detail who supervises the work of the detail. The detail keeps a record of all pertinent data, including weights of charges, lot numbers of powder, and temperature of magazines. In the service of powder the detail removes from the containers the powder charge which is to be served to the gun for the next round, places it with igniter end to the rear on a powder tray, removes the powder tag, and sees that the powder bag is not defective. The detail carries the loaded tray to the emplacement and turns it over to the powder serving detail of the gun squad, receiving an empty tray to be brought back to the magazine for reloading. In addition, the detail maintains the powder handling devices and assists the projectile detail.

Q. What are the duties of the display board operators? *A*.

(1) They are responsible to the gun commander (or chief of section) for the proper operation of the display boards and recording of all data received from the plotting room.

(2) At the command DETAILS, POSTS, they procure chalk, blackboard erasers, forms for recording data, and the telephones, and take post at the display boards.

(3) At the command EXAMINE GUN they clean the display boards if necessary, put on the telephone head sets, test the communication to the plotting room, and report to the gun commander (or chief of section) "Deflection (azimuth) display board in order" or "Range (elevation) display board in order" or report any defects they are unable to remedy without delay.

(4) At the command TARGET they receive deflections (azimuths) or ranges (elevations) from the plotting room, post them on the display boards, and record them on the data forms.

(5) At the command CEASE FIRING they continue posting and recording data received from the plotting room.

Q. What are the duties of the artillery mechanics? *A.* The artillery mechanics, assisted by members of the gun sections, make such minor repairs and adjustments as can be made with the means available. The chief artillery mechanic is the custodian of the supplies pertaining to the gun emplacements to which his battery is assigned. He is responsible for the condition of the store room pertaining to the gun emplacements and the supplies contained therein. The chief mechanic or his assistant issues such equipment, tools, oils, paints, and cleaning materials to the members of the gun sections as are necessary for the service and care of the guns and accessories.

5. Notes on the service of the piece.—*Q.* How should service of the piece be conducted? *A.* The service of the piece should be conducted with dispatch and precision and with as few orders as possible. Commands should be given in the prescribed forms. Except for the necessary orders, reports, and instructions, no talking will be permitted. Cannoneers change position at a run.

Q. What use of signals may be made? *A.*

(1) Signals may be substituted for commands whenever desirable. Verbal commands should be kept to the minimum. During continuous firing no verbal commands should be necessary except in the case of accident or unforeseen emergency.

(2) Signals with whistles or bugles are authorized.

(3) The following visual signals may be used if desired:

(*a*) *Elevate.*—Raise either hand to the height of the head, fingers pointing upward. Move the hand in short upward movements by flexing the hand at the wrist.

(*b*) *Depress.*—Raise either hand to the height of the head, fingers pointing downward. Move the hand in short downward movements by flexing the hand at the wrist.

(*c*) *Right* or *left.*—Motion with either hand, palm turned, and fingers pointing in the desired direction.

(*d*) *Ready.*—Raise and fully extend either arm vertically, hand and fingers open and in prolongation of the arm.

(*e*) *Cease firing.*—Raise the forearm in the front of the forehead, palm to the front, and swing it up and down several times in front of the face.

Q. What is the purpose of the command STAND FAST? *A*. To halt all movements of matériel and personnel.

Q. Who normally gives the command? *A*. The battery executive (assistant battery executive), the chief of section, or the gun commander (chief of squad).

Q. What is the purpose of the command RELAY? *A*. When firing on time interval signal, if it becomes apparent that a piece will not be pointed in time, the battery executive (or assistant battery executive) commands: RELAY.

Q. What is done at the command RELAY? *A*. Display board operators post new data on their display boards. The lanyard, if used, is slacked. The gun pointer and range setter continue to point the piece in direction and elevation as at the command TARGET.

6. Safety precautions.—*Q*. What is the purpose of the safety precautions prescribed in this paragraph? *A*. They are prescribed for peacetime conditions. They indicate as well the procedures to be followed under war conditions but should be interpreted by the personnel concerned according to the circumstances existing at the time of any particular emergency.

Q. Who may give the command CEASE FIRING? *A*. Any individual in the military service will command or signal CEASE FIRING if he observes any condition which makes it unsafe to fire. At the command given when the piece is loaded, lanyards will be detached if firing by lanyard or the safety switch will be opened if firing electrically.

Q. What tests of the firing mechanism will be made before firing? *A*.

(1) The firing mechanism will be inspected and tested frequently and immediately before firing to insure proper operation and functioning of the safety features.

(2) To test the safety features of a mechanism using separate primers a friction primer will be inserted before the breech is rotated. A strong pull will be exerted on the lanyard while the block is being rotated to ascertain if it is possible to fire the primer before the breech is closed and locked. The mechanism will also be tested in a similar manner with an electric primer, the magneto being operated continuously while the breechblock is being closed.

(3) Previous to firing, each primer to be used will be inserted in turn in the obturator spindle in order to test the proper fit of each primer, and the firing leaf and slide will be lowered to their firing position in order to demonstrate that these parts will function properly with each primer.

Q. What precautions should be taken in the handling of primers? *A*.

(1) Prior to firing, the primer pouch will be examined to make certain that it contains live primers only.

(2) Care will be taken not to drop primers.

(3) Primers will not be inserted until after the breechblock has been completely closed and locked in its recess except to test the safety features of the firing mechanism as described in the preceding answer.

(4) Primers will never be inserted or removed by means of the button or wire.

(5) The greatest care will be exercised in lowering the leaf of the firing mechanism.

(6) Fired primers will be discarded as soon as they are removed from the firing mechanism.

(7) Primers that have failed will be handled with great care due to the possibility of a primer hangfire and will be turned in to the ordnance officer for inspection.

Q. How should the lanyard be pulled? *A*. The lanyard should be pulled with a quick, strong pull (not a jerk) from a position to the right of and as near the rear of the piece as conditions of safety will permit.

Q. What are the special precautions relative to the handling of fuzes? *A*.

(1) Projectiles equipped with base detonating fuzes normally will be received properly fuzed for firing. Projectiles equipped with point detonating fuzes normally will be received unfuzed and will be fuzed as required in the following manner:

(*a*) Unscrew the plug from the fuze socket.

(*b*) Insert the fuze, being careful to see that it is fitted with its felt or rubber washer, and screw it home by hand.

(*c*) Screw up the fuze with the fuze wrench but without using any great force.

(*d*) If there is any difficulty in screwing home the fuze, it should be removed and another inserted. If the same trouble is experienced with the second fuze, the shell should be rejected.

(2) The alteration of fuzes is forbidden except when specifically authorized by the Chief of Ordnance.

Q. What precautions are required in the handling of powder charges? *A*. All powder charges will be kept in their containers except the charge which is to be served to the piece for the next succeeding round. The powder charge for any given round will not

be brought near the breech until the preceding round has been fired, the powder chamber sponged, and the face of the mushroom head wiped.

Q. What are the precautions concerning the sponging of the powder chamber? *A*. After each shot the powder chamber will be sponged and the face of the mushroom head wiped with the liquid prescribed for this purpose.

Q. What are the precautions concerning cover for the gun section? *A*. When cover is prescribed, each member of the gun section will be required to take adequate shelter each time the piece is fired.

Q. What precautions must be observed in case of misfire? *A*. A misfire occurs if the piece fails to fire when desired. In case of a misfire all personnel remain clear of the path of recoil, and the piece is kept pointed at the target or at a safe place in the field of fire.

(1) *Primer heard to fire.*—If the primer is heard to fire it will not be removed or the breechblock opened until 10 minutes have elapsed since the primer fired.

(2) *Primer not heard to fire.*—If the primer is not heard to fire, at least three attempts will be made to fire it. If a special device by which the primer can be removed by an individual standing clear of the path of recoil is available, the primer may be removed and examined 2 minutes after the last attempt to fire it. If the primer has not fired, a new one may be inserted and firing continued. If the primer has fired, a new primer will not be inserted nor the breechblock opened until at least 10 minutes have elapsed since the last attempt to fire.

Section II

3-INCH BARBETTE GUN

7. Notes on drill.—*Q*. What is the formation for the 3-inch gun section? *A*. See figure 1.

Q. How is the breechblock operated? *A*.

(1) No. 1 should operate the breechblock with as little jar as possible and always in a uniform, steady manner.

(2) When manning the M1902MI gun, No. 1 should be trained to feel for the firing pin each time he opens the breech in order to make certain that the firing mechanism has returned to the cocked position.

Q. How is the ammunition served to the gun? *A*.

(1) Members of the ammunition squad bring or pass up the ammunition to the left side of the gun, keeping well out of the way of the

gun squad. They pass rounds to No. 2 in the most expeditious manner and in such a way that he is able to grasp the base of the cartridge case with his right hand. Ammunition servers must coordinate their actions to those of No. 2.

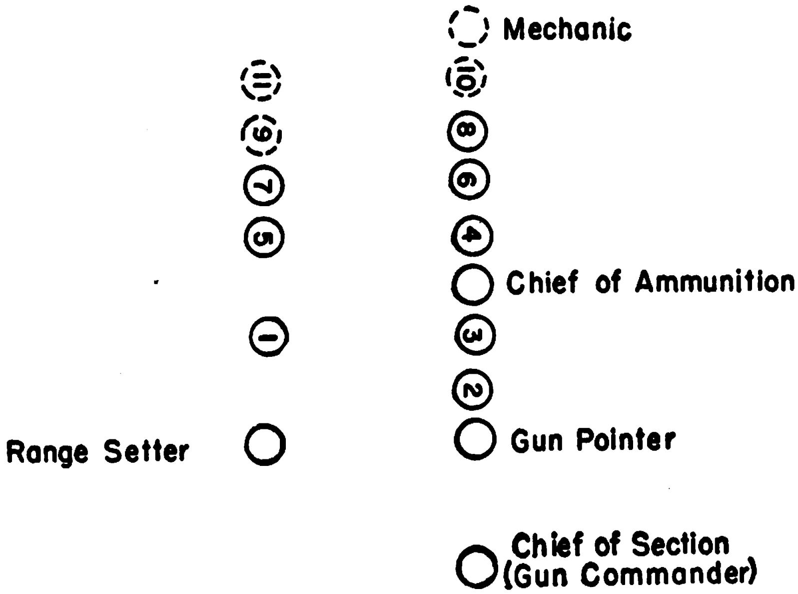


FIGURE 1.—Formation of 3-inch gun section.

(2) To receive the round, No. 2 steps with his left foot toward the ammunition server and grasps the round with his right hand at the base of the cartridge case and his left hand in rear of the ogive. He then resumes his position facing the breech, inserts the nose of projectile in the breech, and removes his left hand. When about one-third of the cartridge case still extends beyond the breech face, he gives the round a final push until his open hand comes in contact with the breech, then, continuing the motion he rotates his hand upward and to the left. No. 2 will hold the next round to be loaded well out of the path of recoil until the gun is back in battery. Smooth, steady loading by No. 2 will do more to assist the gun pointer to get his shots off rapidly than any other one factor in the service of the piece.

Q. What should be done if a round is unloaded from the gun? *A.* The round should be examined to see that the projectile is securely attached to the case.

Q. What special instructions for the service of ammunition must be observed? *A.*

(1) For peacetime firing all cartridges will be tried in the chamber before they are used. Those which do not fit accurately will be rejected.

(2) If a cartridge jams no attempt will be made to drive it home by forcing the block; it will be withdrawn and another substituted.

(3) If a cartridge case is extracted with difficulty, the cause may be a bur around the edge of the chamber; if a bur is found it should be filed smooth.

(4) When using ammunition equipped with the M48 fuze, the setting "superquick" will normally be used. This fuze setting is indicated by the screw-driver slot in the fuze being turned toward "SQ." Before serving ammunition to the gun this setting is checked by a member of the ammunition squad designated by the chief of ammunition. If for any reason it is desired to set the fuze for delay the screw-driver slot is turned until it points toward "delay."

Q. Describe the method of pointing and firing. *A.* The range setter keeps the piece pointed continuously in range. If the lanyard is used the gun pointer commands: FIRE as soon after No. 1 has called "Ready" as the piece is pointed. No. 1 fires the piece. When the firing handle is used, the gun pointer fires the piece.

Q. How is fire simulated during drill in which dummy ammunition is employed? *A.*

(1) (*a*) The piece is pointed in the same manner as for firing.

(*b*) Three dummy rounds are used. Nos. 2, 3, and a member of the ammunition squad take posts, Nos. 2 and 3 at their regular positions and the ammunition server to the left of No. 2. Each man holds a dummy round.

(*c*) At the command COMMENCE FIRING, the process of loading and firing is carried out as with service ammunition. The three dummy rounds are loaded, unloaded, and circulated in as close an approximation of service firing conditions as possible.

(2) Unusual events, such as misfires, which may occur during actual firing will be simulated during the drill. They should be called by the officer in charge, without prior information to the gun squad, and in such a manner as to inject realism into the drill.

Q. What are the posts of the 3-inch gun squad? *A.* See figure 2.

Q. What general duties are performed by the gun section during lulls in the firing or drill? *A.* Each member of the gun section will inspect, clean, and place in the best possible condition the matériel under his charge.

Q. What replacements in the gun squad are required during extended action? *A.* The shock effect of these guns may materially lower the efficiency of the gun pointer and range setter during an extended action. For this reason it is well to have capable replace-

ments for these men. These replacements should be members of the ammunition squad who are assigned work in the magazines or in some other place not directly exposed to concussion.

8. Drill table.—*Q.* What are the duties of the members of the 3-inch gun section at the various commands? *A.* See table I.

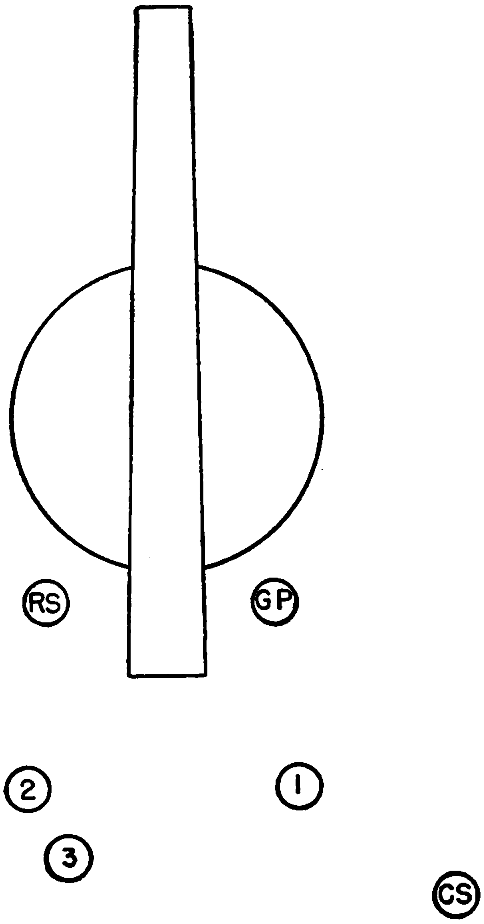


FIGURE 2.—Posts of 3-inch gun squad.

TABLE I.—*Drill table—Service of the piece, 3-inch rapid-fire gun (barbette carriage)*

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Gun pointer.	Gets sights, places it in its seat, and takes post in rear of shoulder piece, facing to front.	(*a*) Examines sight, traversing mechanism, and firing handle mechanism. Puts on telephone head set and tests communication. (*b*) Reports to gun commander, "Traversing in order," or any defects he is unable to remedy without delay.	Takes and reports travel of target, sets deflection ordered, and tracks target.	Changes deflection as ordered, follows target continuously, and fires piece or commands: FIRE, as soon after No. 1 calls "Ready" as the piece is pointed.	Continues to track target until command CEASE TRACKING is given.
Range setter.	Takes post near range scale, facing it.	(*a*) Tests elevating mechanism and cleans and oils gears; puts on telephone head set and tests communication. (*b*) Reports to gun commander, "Elevation in order," or any defects he is unable to remedy without delay.	Lays piece in range.	Keeps piece laid continuously in range in accordance with transmitted data.	Continues to lay piece in range until command CEASE TRACKING is given.
No. 1 (chief of breech).	Gets cotton waste, can of lubricating oil, and sponge; places can convenient to breech and takes post about 2 feet to rear and right of breech, facing it.	(*a*) Removes breech cover and places it at designated place; examines chamber, bore, breechblock threads, and breech mechanism and cleans and oils them if necessary, assisted by Nos. 2 and 3. (*b*) Reports to gun commander, "Breech in order," or any defects he is unable to remedy without delay.	Hooks lanyard.	Opens breech, closes it as soon as cartridge is inserted, and calls "Ready." If there is any difficulty in opening or closing breech, wipes any residue from threads of breechblock and oils mechanism. When the lanyard is used, fires piece at command of gun pointer.	Opens breech. After cartridge has been removed, cleans and oils breechblock and closes breech.

TABLE 1.—*Drill table—Service of the piece, 3-inch rapid-fire gun (barbette carriage)*—Continued.

Details	DETAILS, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
No. 2 (breech detail).	Gets cotton waste, sponge, and lanyard (if used); takes post about 2 feet to rear and left of breech, facing it.	(*a*) Removes muzzle cover and places it at designated place, examines lanyard; examines, cleans, and oils breech recess. (*b*) No duties.	Hands lanyard to No. 1.	Receives cartridge from member of ammunition squad and inserts it in chamber, taking care that point of projectile does not strike breech. If there is any difficulty in opening or closing breech, wipes any residue from threads of breech recess and oils threads if they become dry.	Cleans and oils breech recess.
No. 3.	Gets hand extractor and a pair of asbestos gloves; takes post about 3 feet to rear and 1 foot to left of breech, facing it.	(*a*) Removes recoil cylinder filling plug. If cylinder is not full, gets measure of recoil oil and funnel; fills cylinder and after inspection by gun commander replaces filling plug, oil measure, and funnel. (*b*) No duties.	Puts on gloves.	Receives empty cartridge case as it is ejected and lays it aside; uses hand extractor when necessary.	Withdraws cartridge.

SECTION III

6-INCH BARBETTE GUN

9. Notes on drill.—*Q.* What is the formation for the 6-inch gun section (barbette carriage)? *A.* See figure 3.

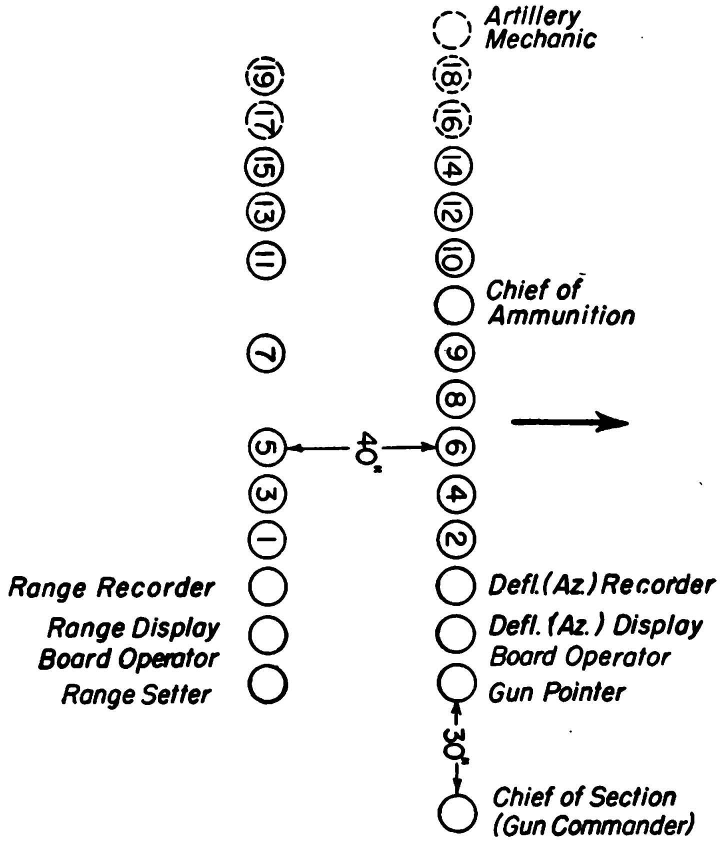


FIGURE 3.—Formation of gun section for 6-inch gun on barbette carriage.

Q. What duties must No. 3 perform to insure proper operation of the firing mechanism? *A.*

(1) Before firing, No. 3 assembles the firing mechanism to the gun and sees that the vent is clear and that the primer seat is clean and unpitted. He sees that the firing leaf cannot be drawn back until the slide has been lowered and the breechblock closed and locked.

(2) In firing, No. 3 hooks the lanyard (if used) and inserts a primer after the breechlock is closed and locked. He lowers the slide of the firing mechanism completely down before attempting to fire the gun,

otherwise the primer may be blown to the rear, endangering the gun squad. After the gun has been fired he unhooks the lanyard, and as soon as the breech is open he removes the fired primer.

(3) It is of great importance that No. 3 clean the primer seat and vent after each shot. When the primer sticks it is usually due to powder residue having collected between the primer and the primer seat or vent, or the primer seat having become pitted. A fired primer that has become stuck may be removed by using a drift through the vent, at the same time raising the firing mechanism slide.

Q. What are the posts of the gun squad for the 6-inch gun on the barbette carriage? *A.* See figure 4.

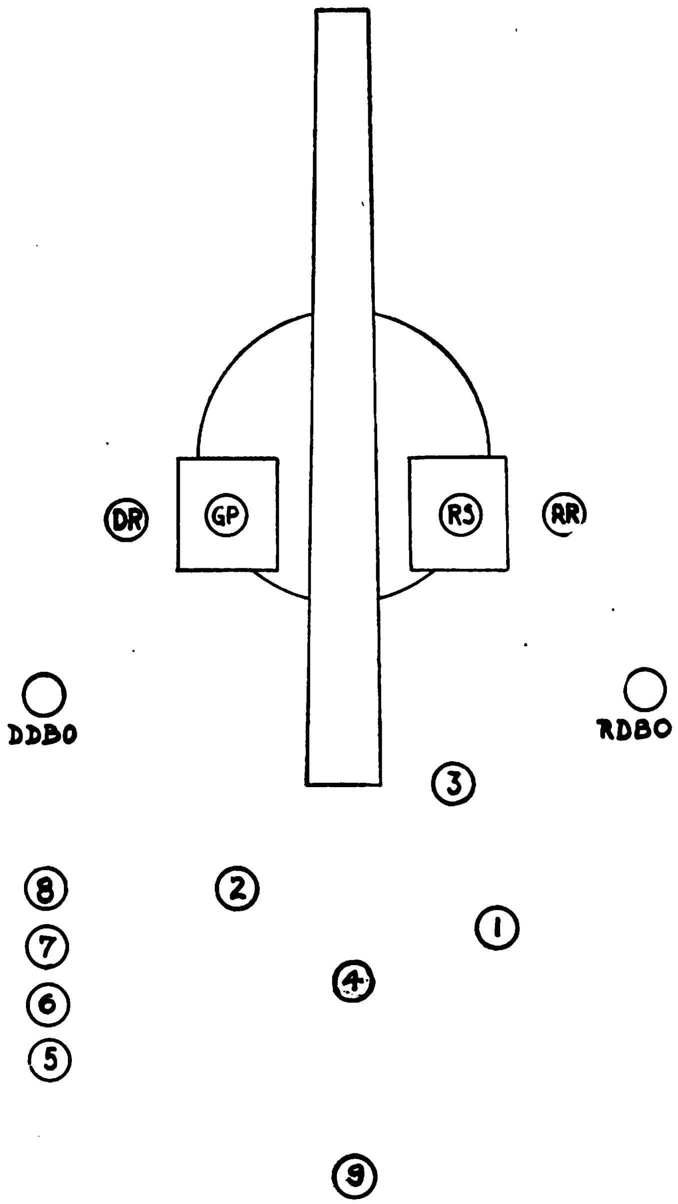


FIGURE 4.—Posts of gun squad for 6-inch gun on barbette carriage.

Q. How is the 6-inch gun on barbette carriage loaded? *A*. When the command COMMENCE FIRING is given, the chief of section commands: LOAD. No. 1 opens the breech. No. 2 inserts the loading tray in the breech recess, being careful not to bur or otherwise damage the threads in the breech. No. 5 or 6 inserts a projectile in the breech. No. 4 places the head of the rammer against the base of the projectile and rams it firmly into its seat. No. 2 withdraws the loading tray. No. 7 or 8 places the powder tray with powder charge in the breech recess and No. 2 pushes the powder into the chamber by hand to such distance that the breech in closing will give the charge a final push into the chamber.

Q. What are the general duties of the ammunition squad? *A*. The chief of ammunition divides the cannoneers of the ammunition squad into two details, the projectile detail and the powder detail. The size of each detail depends on local conditions and is determined by the battery commander.

(1) *Projectile detail.*—The chief of ammunition designates one of the cannoneers as chief of detail who supervises the work of the detail. Previous to and during firing, the detail moves projectiles from the magazine to the serving table, carrying the projectiles by hand if the battery is not equipped with hoists. In addition, the detail maintains the ammunition and ammunition-handling apparatus, and polices the magazines and corridors.

(2) *Powder detail.*—The chief of ammunition designates one of the cannoneers as chief of detail who supervises the work of the detail. The detail keeps a record of all pertinent data including weights of charges, lot number of powder, and temperature of magazines. In the service of powder, the detail removes from the container the powder charge which is to be served to the gun for the next round, places it, with igniter end to the rear, on a powder tray, removes the powder tag, and sees that the powder bag is not defective. The detail carries the loaded tray to the emplacement and turns it over to the powder-serving detail of the gun squad, and receives an empty tray to be brought back to the magazine for reloading. In addition, the detail maintains the powder-handling devices and assists the projectile detail.

10. Drill table.—*Q*. What are the duties of the members of the gun section for the 6-inch gun on barbette carriage? *A*. See table II.

TABLE II.—*Drill table—Service of the piece, 6-inch gun (barbette carriage)*

Details	DETAILS, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Gun pointer.	Procures the sight, places it in its seat, and takes post on the gun pointer's platform	(*a*) Examines sight and verifies adjustment of the azimuth index; examines traversing merchanism and electric firing mechanism and circuit (if used). (*b*) Reports to the gun commander, "Sight, traversing mechanism, and electric firing mechanism (if used) in order," or defects he is unable to remedy.	See note 1.	Keeps the piece pointed in direction. In case II firing repeats to the deflection recorder the data he sets on the sight; fires the piece or gives the command: FIRE, as soon after the gun commander has called or signaled "Ready" as the piece is pointed. When so directed, he endeavors to locate the position of the splash of the shot and corrects his deflection if necessary. In case III firing, he sets the azimuth index to the azimuth posted on the display board and calls, "Azimuth set."	Keeps the piece pointed in direction until the command CEASE TRACKING is given.
Range setter.	Takes post facing the range scale.	(*a*) Examines elevating mechanism; cleans and oils the gears if necessary. (*b*) Reports to the gun commander, "Elevation in order," or defects he is unable to remedy.	See note 2.	Lays the piece in range; calls, "Range set."	Keeps the piece laid in range until the command CEASE TRACKING is given.
No. 1 (breech detail).	Procures cotton waste, a can containing lubricating oil, and a sponge, places them in a convenient place and takes post 1 yard to the rear and right of the breech, facing it.	(*a*) Removes the breech cover and places it at the designated place; examines, cleans, and oils the breechblock and breech mechanism. (*b*) No duties.	No duties.	Opens the breech, cleans and oils the block if necessary, and as soon as the powder charge has been inserted, closes the breech. Seizes the lever handle as soon as possible after the gun is fired and opens the breech for the next round.	Opens the breech when so directed.

No. 2 (breech detail).	Procures the loading tray and cotton waste. He places the tray convenient to the breech and takes post 2 feet to the rear and left of the breech, facing it.	(*a*) Examines, cleans, and oils the breech recess and gas check seat. (*b*) No duties.	No duties.	After the breech is opened, he wipes off the mushroom head and gas check seat and puts the loading tray in place. Withdraws the loading tray after the projectile has been rammed to permit the insertion of the powder tray. and pushes the powder into the chamber by hand. Unhooks the lanyard (if one is used) after the piece is fired.	When dummy ammunition is used, he withdraws the powder charge and inserts the loading tray.
No. 3 (chief of breech).	Procures the lanyard (if one is used), primers, pouch, punch, drill, reamer, and firing mechanism, and takes post 2 feet to the right of the breech on line with its face, facing it.	(*a*) Examines the vent and firing mechanism, cleans the vent and primer seat, examines the breech mechanism, breechblock, breech recess, chamber, and bore, and gives the necessary orders for putting them in condition for firing; places the firing mechanism in position. (*b*) Reports to the gun commander, "Breech in order," or defects he is unable to remedy.	No duties.	Inserts the primer after the breechblock is closed and locked and lowers the leaf of the firing device completely down; hooks the lanyard (if one is used) before the primer is inserted; pulls the lanyard at the command FIRE. As soon as the breech is open after firing, he removes the old primer, clears the vent, and cleans the primer seat.	Removes the primer when so directed. Supervises the unloading when dummy ammunition is used.
No. 4 (rammer detail).	Procures the extractor and rammer, places the extractor in a convenient position, and takes post about 4 feet in rear of the breech, facing it. Holds the rammer vertical with his right hand, its head on the platform by his right foot.	(*a*) Assists the breech detail in cleaning. (*b*) No duties.	No duties.	As soon as a projectile is placed on the loading tray, he rams it firmly into its seat.	When dummy ammunition is used, he brings up the extractor and withdraws the dummy projectile to where it can be removed by No. 5 or 6.

NOTES

1. At the command TARGET, the gun pointer in case II firing sets on the sight the deflection recorded on the display board, traverses the piece so that the line of sight is on the target; calls "On target", continues to set data recorded on the display board and follows the target. In case III firing he traverses the gun so that the azimuth index is set to the azimuth posted on the display board; calls "Azimuth set", continues to traverse the gun to data recorded on the display board.
2. At the command TARGET, the range setter lays the piece in range continuously according to data recorded on the display board.

TABLE II.—*Drill table—Service of the piece, 6-inch gun (barbette carriage)*—Continued.

Details	DETAILS, POST	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Nos. 5 and 6 (projectile detail).	No. 5 procures the wrench for filling plugs, a funnel, and a measure containing recoil oil. Takes post with No. 6 near a shot truck, facing the gun.	(*a*) No. 5 unscrews the filling plugs and fills the recoil cylinder. The gun commander inspects the cylinder, after which No. 5 screws the filling plugs well home, and replaces his implements. No. 6 removes the muzzle cover and places it at the designated place; assists the range setter in cleaning and oiling the elevating mechanism. (*b*) No duties.	No duties.	Nos. 5 and 6 alternately pick up projectiles from the shot truck and place them on the loading tray. The number not loading a projectile arranges the remaining projectiles on the shot truck and keeps the truck convenient to the breech.	When dummy ammunition is used, Nos. 5 and 6 alternately remove the dummy projectiles from the breech recess and place them on the shot truck.
Nos. 7 and 8 (powder-serving detail).	Take post at that part of the loading platform most convenient to the source of powder supply.	(*a*) Remove the drip pans and inspect the powder trays. (*b*) No duties.	No duties.	Nos. 7 and 8 alternate in bringing up powder charges. The end of the powder tray is placed in the breech recess after the loading tray has been removed. No. 2 pushes the powder into the chamber by hand.	When dummy ammunition is used, Nos. 7 and 8 alternate in bringing up the empty powder trays to receive the dummy powder charges.
No. 9 (sponge detail).	Procures the chamber sponge and a vessel containing liquid for sponging, places them in a convenient position, and takes post near the chamber sponge, facing the gun.	(*a*) Brings up the chamber sponge when called for and sponges the chamber. (*b*) No duties.	No duties.	Dips the chamber sponge in the liquid for sponging and allows the excess liquid to run off. As soon as the breechblock is opened after each shot, he sponges the chamber as quickly as practicable.	No duties.

Section IV

6-INCH DISAPPEARING GUN

11. Notes on drill.—*Q*. What is the formation for the 6-inch gun section (disappearing carriage)? *A*. See figure 5.

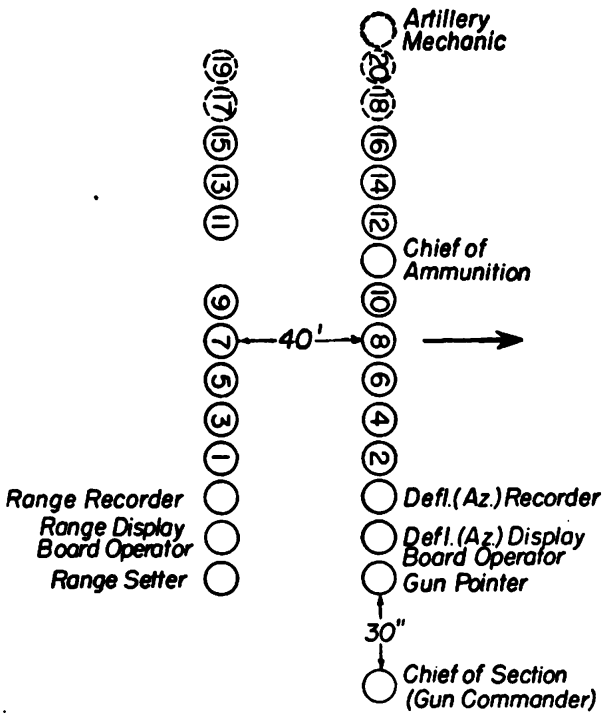


FIGURE 5.—Formation of gun section for 6-inch gun on disappearing carriage.

Q. What duties must No. 3 perform to insure proper operation of the firing mechanism? *A*.

(1) Before firing, No. 3 assembles firing mechanism to the gun and sees that the vent is clear and that primer seat is clean and unpitted. He sees that firing leaf cannot be drawn back until slide has been closed and breechblock closed and locked.

(2) In firing, No. 3 hooks lanyard (if used) and inserts a primer after breechblock is closed and locked. He completely closes slide of firing mechanism before attempting to fire the gun, otherwise the primer may be blown to the rear endangering the gun squad. After the gun has been fired he unhooks lanyard, and as soon as the breech is open he removes fired primer.

(3) It is of great importance that No. 3 clean the primer seat and vent after each shot, for when a primer sticks it is usually due

to powder residue having collected between the primer and the primer seat or vent, or the primer seat having become pitted. A fired primer that has become stuck may be removed by using a drift through the vent, at the same time opening the firing mechanism slide.

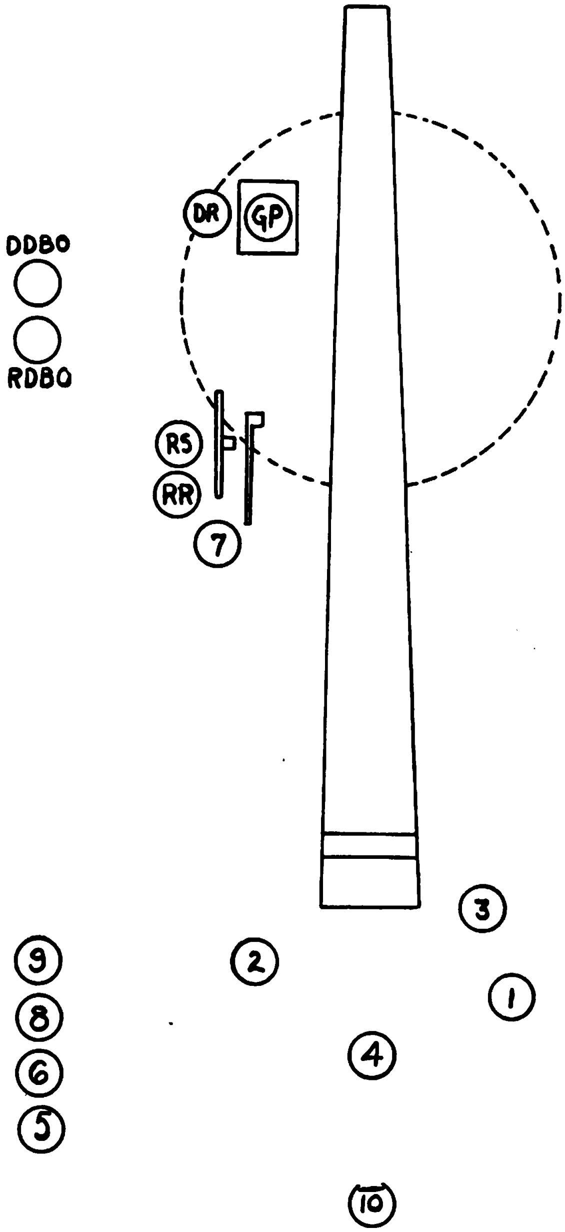


FIGURE 6.—Post of gun squad for 6-inch gun on disappearing carriage.

Q. What are the posts of the gun squad for the 6-inch gun on disappearing carriage? *A*. See figure 6.

Q. How is the 6-inch gun on disappearing carriage loaded? *A*. When the command COMMENCE FIRING is given, the gun commander

commands: LOAD, No. 1 opens breech. No. 2 inserts loading tray in breech recess, being careful not to bur or otherwise damage the threads in the breech. No. 5 or No. 6 inserts projectile in breech. No. 4 places head of rammer against base of projectile and rams it firmly into its seat. No. 2 withdraws loading tray. No. 8 or No. 9 places powder tray with powder charge in breech recess, and No. 2 pushes powder into chamber by hand to such distance that the breech in closing will give the charge a final push into the chamber.

Q. How is the gun tripped into battery? *A.*

(1) The gun is held from battery by the engagement of pawl teeth or retracting pinion teeth with the teeth in the cross head which prevents the counterweight from descending. Raising the tripping lever disengages the teeth, enabling the counterweight to descend and the gun to rise into battery, while safety latches retain the pawl or pinion teeth clear of the descending cross head teeth. At the command IN BATTERY, No. 7 grasps tripping lever, and at the command TRIP, raises it quickly to the full limit of upward movement. A slight downward movement on the tripping lever will indicate if the safety latches have engaged.

(2) If the gun fails to go completely into battery, the gun commander orders Nos. 7 and 10 to use the pinch bars. These are engaged in the notches on the chassis and the gun is forced into battery. Failure of the gun to go completely into battery will be immediately reported to the battery commander in order that the necessary action may be taken.

Q. How is the gun retracted? *A.*

(1) *Carriage M1898 or M1903.*—At the command FROM BATTERY given by the gun commander, No. 7 goes to retraction crank, releases retaining pawl, and turns crank to permit pulling out cables. Nos. 5 and 6 mount carriage. Nos. 1 and 2 pull out cables and pass ends to Nos. 5 and 6, who place loops of cables on hooks. No. 7 takes in slack. Nos. 8 and 9 take positions at retraction crank. When the gun commander commands: HEAVE, Nos. 8 and 9 turn crank. Nos. 5 and 6 relieve Nos. 8 and 9 when directed by the gun commander. Care is taken to see that the cables are under equal tension and are guided to the pulleys without kinks. The gun commander designates a cannoneer to call off the inches of recoil indicated by the engagement of the pawl teeth with the cross head teeth. When the gun has reached the loading position, the gun commander commands: HALT. No. 7 lets out enough slack to enable Nos. 1 and 2 to take the loops off the hooks.

(2) *Carriage M1905*.—At the command FROM BATTERY given by the gun commander, No. 7 raises safety latch handle and Nos. 5, 6, 8, and 9 take positions at retracting cranks. When the gun commander commands: HEAVE, they turn retracting cranks, retracting the gun. The gun commander designates a cannoneer to call off the inches of recoil indicated by the engagement of the retracting pinion teeth with the retraction rack teeth. When the gun has reached the loading position, the gun commander commands: HALT. The men on the retracting cranks remove the cranks and place them on the chassis hooks.

Q. What are the requirements for a powder-serving tray? *A*. The powder-serving tray will be made locally. It will be of wood of sufficient dimensions to carry the powder charge. It will be so shaped that the forward end will cover the screw threads in the breech. At least two trays will be provided for each gun.

12. **Drill table.**—*Q*. What are the duties of the members of the gun section for the 6-inch gun on disappearing carriage? *A*. See table III.

TABLE III.—*Drill table—Service of the piece, 6-inch guns (disappearing carriage)*

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Gun pointer.	Procures sight, places it in its seat, and takes post on gun pointer's platform.	(*a*) Examines sight and verifies adjustment of azimuth index; examines traversing mechanism and electric firing circuit (if used). (*b*) Reports to gun commander, "Sight, traversing mechanism, and electric firing circuit (if used) in order," or defects he is unable to remedy.	See note 1.	Keeps piece pointed in direction. In case II firing, repeats to deflection recorder the data he sets on sight; fires piece or gives command: FIRE, as soon after gun commander has called or signalled "Ready" as piece is pointed. When so directed, he endeavors to locate position of splash of shot and corrects his deflection if necessary. In case III firing, he sets azimuth index to azimuth posted on the display board and calls "Azimuth set."	Keeps piece pointed in direction until command CEASE TRACKING is given.
Range setter.	Takes post facing range scale.	(*a*) Examines elevating and retracting mechanisms; cleans and oils gears if necessary. (*b*) Reports to gun commander, "Elevation and retraction in order," or defects he is unable to remedy.	See note 2.	Lays piece in range; calls "Range set."	Keeps piece laid in range until command CEASE TRACKING is given.

NOTES

1. At the command TARGET, gun pointer in case II firing, sets on sight the deflection recorded on display board; traverses piece so that line of sight is on target; calls "On target"; continues to set data recorded on display board and follows target. In case III firing he traverses gun so that azimuth index is set to azimuth posted on display board; calls "On target"; continues to traverse gun to data recorded on display board.
2. At the command TARGET, range setter lays piece in range continuously according to data recorded on display board.

TABLE III.—*Drill table—Service of the piece, 6-inch guns (disappearing carriage)*—Continued.

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
No. 1 (breech detail).	Procures cotton waste, can containing lubricating oil, and sponge; places them in a convenient place, and takes post 1 yard to the rear and right of breech, facing it.	(*a*) Removes breech cover and places it at designated place; cleans and oils breechblock and breech mechanism. (*b*) No duties.	No duties.	Opens breechblock, cleans and oils if necessary, and as soon as powder charge has been inserted, closes breech; after piece has been fired, he seizes operating lever handle as soon as gun has recoiled within reach and opens breech for next charge.	Opens breech if so directed.
No. 2 (breech detail).	Procures loading tray and cotton waste; places tray convenient to breech and takes post 2 feet to rear and left of breech, facing it.	(*a*) Examines, cleans, and oils breech recess and gas check seat. (*b*) No duties.	No duties.	After breech has been opened, he wipes off mushroom head and gas check seat and puts loading tray in place; withdraws loading tray after projectile has been rammed to permit insertion of the powder-serving tray, and pushes powder off tray into chamber by hand to such distance that breechblock will give powder charge a final push in closing.	When dummy ammunition is used, withdraws dummy powder charge.
No. 3 (chief of breech).	Procures lanyard (if used), primer pouch, primers, punch, drill, reamer, and firing mechanism; takes post 2 feet to right of breech on line with its face, facing it.	(*a*) Examines vent and firing mechanism; cleans vent and primer seat; places firing mechanism in position; examines breech mechanism, breechblock, breech recess, chamber, and bore; gives necessary orders for putting them in order for service. (*b*) Reports to gun commander, "Breech in order." or defects he is unable to remedy.	No duties.	After breechblock has been closed and locked, hooks lanyard (if used); inserts primer and completely closes leaf of firing mechanism; commands: 1. IN BATTERY, 2. TRIP. As piece goes into battery he steps to right rear; pulls lanyard (if used) at command FIRE. He unhooks short lanyard (if used) as soon as piece is fired. As soon as breech is open after piece has been fired, he removes old primer, clears vent, and cleans primer seat.	Removes primer when so directed.

No. 4 (rammer detail).	Procures extractor and rammer; places extractor in a convenient position; takes post 4 feet in rear of breech, facing it, holding rammer in his right hand in a vertical position, its head by his right foot.	(*a*) Assists breech detail in cleaning. (*b*) No duties.	No duties.	As soon as projectile has been placed on loading tray, he rams it firmly into its seat.	When dummy ammunition is used, brings up extractor and withdraws dummy projectile into a position where it can be removed by No. 5 or No. 6.
Nos. 5 and 6 (projectile detail).	Take posts near shot truck.	(*a*) No. 5 assists No. 7 in filling recoil cylinders. No. 6 removes muzzle cover and places it at designated place; assists range setter in examining elevating and retracting mechanisms and in cleaning and oiling gears. (*b*) No duties.	No duties.	Alternately pick up projectiles from shot truck and place them on loading tray. The number not loading a projectile keeps shot truck convenient to breech.	When dummy ammunition is used, they alternately remove dummy projectiles from breech recess and place them on shot truck.
No. 7 (tripping detail).	Procures wrench for filling plugs, measure containing recoil oil and funnel; takes post at tripping lever which is nearer safety switch.	(*a*) Fills recoil cylinders if necessary and notifies gun commander that cylinders are ready for inspection. After inspection he screws both plugs well home and replaces his implements. (*b*) No duties.	No duties.	Raises tripping levers at command TRIP given by No. 3, and, if firing by electricity, closes firing switch as soon as gun is in battery.	No duties.
Nos. 8 and 9 (powder-serving detail).	Take post convenient to source of powder supply.	(*a*) Remove drip pans and in-inspect powder trays. (*b*) No duties.	No duties.	Alternate in serving powder to gun. The end of powder tray is placed in breech recess after loading tray has been removed, and No. 2 pushes powder into chamber by hand.	When dummy ammunition is used, they alternate in bringing up empty powder trays to receive dummy powder charges.
No. 10 (sponge detail).	Procures chamber sponge and vessel containing liquid for sponging, places them near railing, and takes post near chamber sponge, facing gun.	(*a*) Brings up chamber sponge when called for and sponges chamber. (*b*) No duties.	No duties.	Dips chamber sponge in liquid for sponging and allows excess liquid to run off. As soon as breechblock is open after each shot, he sponges chamber as quickly as practicable.	No duties.

SECTION V

10-INCH DISAPPEARING GUN

13. Notes on drill.—*Q*. What is the formation for the 10-inch gun section (disappearing carriage)? *A*. See figure 7.

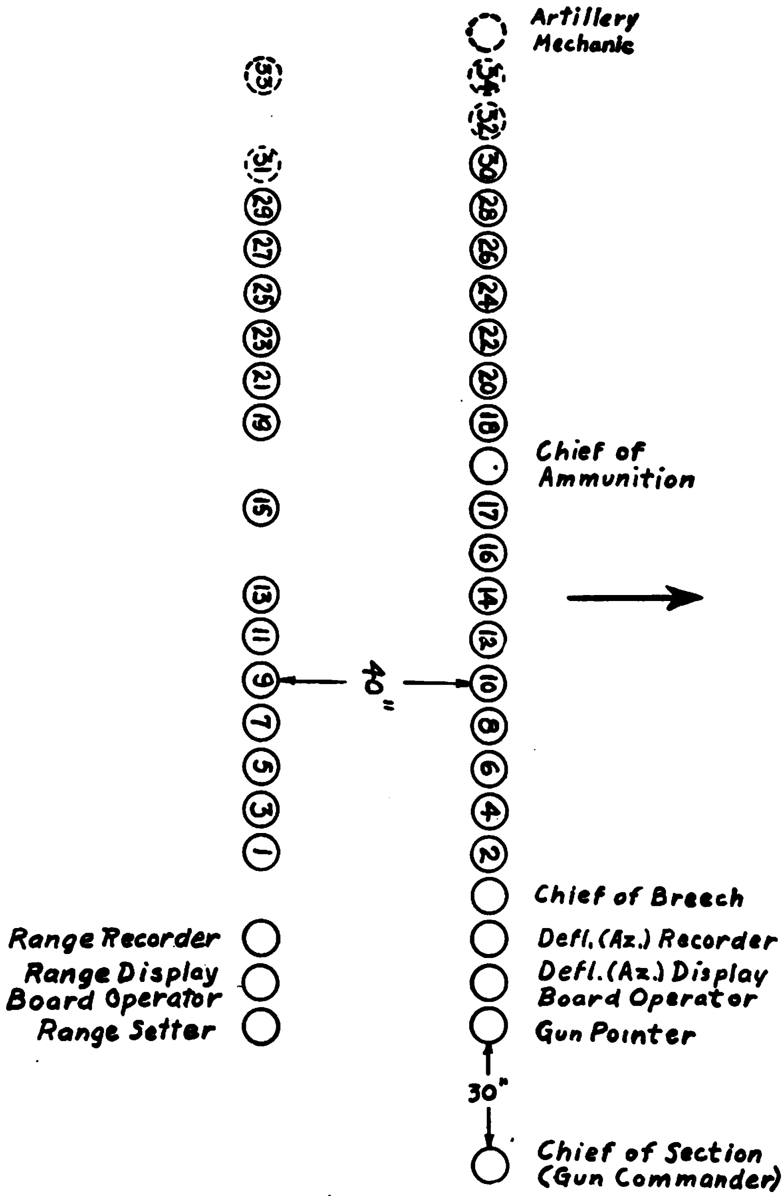


FIGURE 7.—Formation of 10-inch gun section.

Q. What are the posts of the gun squad for the 10-inch gun? *A*. See figure 8.

Q. What duties must No. 3 perform to insure proper operation of the firing mechanism? *A*.

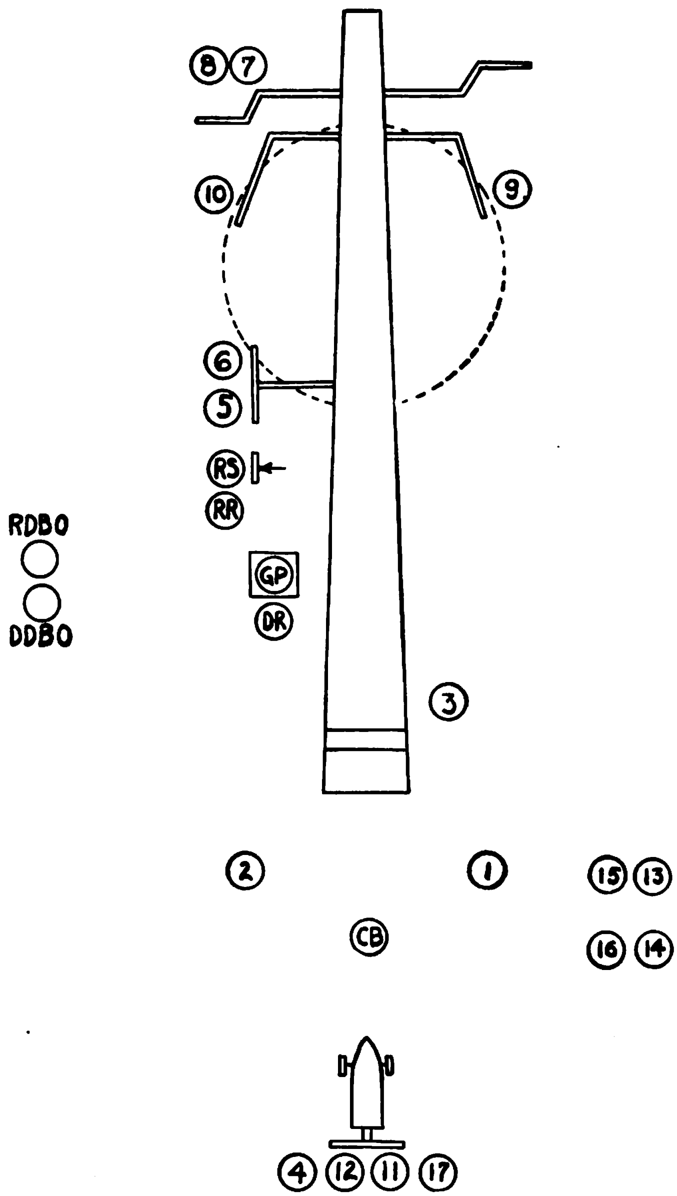


FIGURE 8.—Posts of gun squad for 10-inch gun.

(1) Before firing, No. 3 assembles the firing mechanism to the gun and sees that the vent is clear and that the primer seat is clean and unpitted. He sees that the firing leaf cannot be drawn back until the slide has been closed and the breechblock closed and locked.

(2) In firing, the chief of breech hooks the lanyard (if used), and No. 3 inserts a primer after the breechblock is closed and locked.

No. 3 completely closes the slide of the firing mechanism before attempting to fire the gun, otherwise the primer may be blown to the rear endangering the gun squad. After the gun has been fired the chief of breech unhooks the lanyard, and as soon as the breech is open No. 3 removes the fired primer.

(3) It is of great importance that No. 3 clean the primer seat and vent after each shot, for when a primer sticks it is usually due to powder residue having collected between the primer and the primer seat or vent, or the primer seat having become pitted. A fired primer that has become stuck may be removed by using a drift through the vent, at the same time opening the firing mechanism slide.

Q. Describe the operation of the breech mechanism. *A*.

(1) *Breech mechanism M1895*.—The service of the piece as given in the drill table (table IV) is for a gun fitted with an M1895 breech mechanism.

(*a*) To *open* the breech, the chief of breech unhooks the lanyard (when one is used) from the eye of the firing leaf, and No. 2 turns the crank continuously in a clockwise direction until the tray comes to rest against the hinge plate and the securing latch catches.

(*b*) To *close* the breech, No. 1 releases the securing latch and turns the crank in a counterclockwise direction until the projecting shoulder on a rotating lug striking the gear prevents further motion. The latch is released before the truck is withdrawn from the breech, No. 1 holding the breech open by the operating crank until time to close it.

(*c*) It will be found convenient to fasten a wire around the piece back of the elevating band. This wire should have a loop in it in which the safety lanyard (if one is used) may be hooked during the loading. The chief of breech after unhooking the lanyard swings it over the teeth of the breech mechanism and hooks it in the loop of the wire. Thus it is kept from being caught in the mechanism and is convenient to the chief of breech when the time comes to hook it again.

(2) *Breech mechanism M1888*.—If the gun is fitted with an M1888 breech mechanism, the duties of Nos. 1 and 2 are changed as follows:

(*a*) To *open* the breech, No. 2 releases the rotating crank by turning the wing nut of the catch to the left, and then turns the rotating crank clockwise, as indicated by the "open" arrow, until it is stopped in a horizontal position and is secured by its catch; No. 1 turns the translating crank briskly counterclockwise. When the shoulders of the groove strike against the ends of the rails, the block stops short and the shock frees the tray latch from its catch; No. 1 swings the

tray and block to the right until the securing latch engages in the catch.

(*b*) To *close* the breech, No. 2 releases the securing latch from its catch; No. 1 swings the tray and block around to the left smartly; No. 2 seizes the handle of the tray and continues the swinging of the block until the tray butts against and is latched to the face of the breech, then he turns the translating crank clockwise until the breech is translated completely; No. 1 releases the rotating crank by turning the wing nut and turns the rotating crank counterclockwise, as indicated by the "close" arrow, until it is stopped in a vertical position and is secured by its catch.

Q. How is the 10-inch gun loaded? *A*.

(1) At the command LOAD, the breech is opened and the truck detail moves the truck up to the face of the breech. Nos. 1, 2, 4, 9, and 10 man the rammer as near the outer end as possible. No. 1 places the head of the rammer against the base of the projectile. As soon as the truck is brought up against the face of the breech, No. 12 sets the brake. At the command HOME, given by the chief of breech, the men on the rammer push the projectile forward off the truck and into the breech. At the command RAM, given by the chief of breech as soon as the base of the projectile is just inside the powder chamber, the projectile is pushed forward until it is seated. The projectile is rushed forward in one motion at increasing speed so that it will have its fastest movement when it comes up hard against its seat. The truck is withdrawn and run off to one side. Nos. 9 and 10 quit the rammer for the tripping levers. Nos. 1, 3, and 4 move back far enough so that the powder serving detail can place the nose of the powder tray in the breech recess. No. 1 places the head of the rammer against the base of the powder charge, and at the command RAM, given by the chief of breech, the men on the rammer push the powder into the powder chamber to such distance that the breechblock in closing will give the powder a final push into the chamber. No. 4 then replaces the rammer on the hooks.

(2) An alternate method of powder service may be employed in batteries where the shot trucks are equipped with powder trays. In such cases, a shot truck is loaded with a projectile by the projectile detail and then with a powder charge by the powder detail. The truck detail takes the completely loaded shot truck to the gun. After the truck is run up to the breech, the rammer detail rams the projectile and then the powder directly from the shot truck. The empty truck is withdrawn and turned over to the projectile detail.

Q. How is the gun tripped into battery? *A*.

(1) The gun is held from battery by the engagement of pawls with the teeth in the cross head which prevents the counterweight from descending. Raising the tripping levers releases the pawls from the cross head teeth enabling the counterweight to descend and the gun to rise into battery, while safety latches retain the pawls clear of the descending cross head teeth. At the command IN BATTERY, Nos. 9 and 10 seize the tripping levers, and at the command TRIP, raise them quickly to the full limit of upward movement. A slight downward movement on the tripping levers will indicate if the safety latches have engaged.

(2) If the gun fails to go completely into battery, the gun commander orders Nos. 4, 9, 10, and 17 to use the pinch bars. These are engaged in the notches on the chassis and the gun is forced into battery. Failure of the gun to go completely into battery will be immediately reported to the battery commander in order that the necessary action may be taken.

Q. How is the gun retracted? *A.*

(1) *By hand.*—(*a*) At the command FROM BATTERY, given by the gun commander, No. 7 releases the retaining pawl and turns the speed crank to permit the pulling out of the cables. Nos. 3 and 4 mount chassis and Nos. 9 and 10 mount gun levers. Nos. 1 and 2 pull out cables to their full length and pass the ends to Nos. 3 and 4, who pass the cables to Nos. 9 and 10, who place ends of cables on hooks. No. 7 then throws on retaining pawl and turns speed crank to take up all slack. No. 8 pushes in clutch, Nos. 3, 4, 9, and 10 return to loading platform, and Nos. 7 and 8 put on retraction cranks.

(*b*) The gun squad is divided into two reliefs by the gun commander. The first relief takes post at the retraction cranks, and at the command HEAVE, starts to retract the gun. The reliefs alternate as directed by the gun commander. Care is taken to see that the cables are under equal tension and are guided to the pulleys without kinks. As soon as the cross head teeth engage their pawls, the retraction shaft retaining pawl is thrown off, and remains off until the cables have been unhooked from the gun levers.

(*c*) The gun commander designates a cannoneer to call off the notches of recoil indicated by the engagement of the pawls with the cross head teeth. When the gun has reached the loading position, the gun commander commands: HALT, Nos. 7 and 8 remove retraction cranks. No. 7, using speed crank, lets out enough slack to enable Nos. 1 and 2 to unhook cables. After the cables are unhooked, No. 7 takes up all slack with speed crank and then throws retaining pawl on. No. 8 then pulls out clutch.

(2) *By power.*—Assuming the idler to be out of gear, the cables to be hooked to the gun levers, the slack taken out by No. 7, and the clutch thrown in by No. 8, at the command HEAVE, given by the gun commander, No. 8 throws the idler in gear. As soon as this is done, the range setter closes the main switch of the controller cabinet and moves the arm so as to turn on the power. The movements at the command HALT are the same as those prescribed for hand retraction, except that the range setter pulls the main switch of the controller cabinet, after which No. 8 throws the idler out of gear. The cables are then unhooked and the slack taken up as prescribed for hand retraction.

Q. How are shot trucks adjusted? *A.* Before firing, shot trucks are adjusted to the highest point to which it is anticipated that the gun will recoil, since a downward adjustment is much more easily and rapidly made than an upward one. Marks corresponding to "notches of recoil" may be placed on the shot trucks to facilitate loading after the first round has been fired.

14. Drill table.—*Q.* What are the duties of the members of the gun section for the 10-inch gun? *A.* See table IV.

TABLE IV.—*Drill table—Service of the piece, 10-inch gun (disappearing carriage)*

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Gun pointer.	Procures the sight, places it in its seat, and takes post on the gun pointer's platform.	(a) Examines sight and verifies adjustment of azimuth index; examines and tests traversing mechanism and electric firing mechanism and circuit (if used). (b) Reports to gun commander, "Sight and traversing mechanism in order," or any defects he is unable to remedy without delay.	See note 1.	Keeps the piece laid in direction. In case II firing, repeats to the recorder the deflection he sets on the sight; fires the piece or gives the command FIRE as soon after the gun commander has called or signaled "Ready" as the piece is pointed. When so directed, endeavors to locate the position of the splash of the shot and corrects his deflection if necessary. In case III firing, sets the azimuth index to the azimuth posted on the display board and calls "Azimuth set."	Keeps the piece laid in direction until the command CEASE TRACKING is given.
Range setter.	Takes post facing the range scale.	(a) Examines elevating and retracting mechanisms; cleans and oils the gears, if necessary. (b) Reports to the gun commander, "Elevation and retraction in order," or defects he is unable to remedy.	See note 2.	Lays the piece in range; calls "Range set."	Keeps the piece laid in range until the com imand CEASE TRACKING s given.
Chief of breech.	Posts his detail after assuring himself that each man has procured the necessary cleaning material and equipment; takes post 2 yards in rear of the breech, facing it.	(a) Examines the breech mechanism, breechblock, breech recess, chamber and bore, and gives the necessary orders for cleaning and putting them in condition for service. (b) Reports to the gun commander, "Breech in order," or defects he is unable to remedy.	No duties.	Gives the command: 1. HOME, 2. RAM, for ramming the projectile. At the command HOME the projectile is pushed off the truck, and RAM is given when the base of the projectile is just inside the powder chamber. Also gives the command: RAM, for ramming the powder charge. After the breechblock has been closed, hooks the lanyard (if used) to the firing leaf before the primer is inserted. After the primer has been inserted and the firing	Unhooks the lanyard (if used). Supervises the unloading if dummy ammunition is used.

				leaf completely lowered, commands: 1. IN BATTERY, 2. TRIP. After the piece has been fired, unhooks the lanyard.	
No. 1 (breech detail).	Procures cotton waste, can containing lubricating oil, and sponge; places them in a convenient place, and takes post 1 yard to the rear and right of the breech, facing it.	(*a*) Removes the breech cover and places it at the designated place; cleans and oils the breechblock and breech mechanism. (*b*) No duties.	No duties.	Places the head of the rammer against the base of the projectile as the truck approaches the breech, assists in ramming the projectile and powder, and closes the breech; assists in sponging the chamber.	Cleans the breechblock and breech mechanisms. Assists in withdrawing the dummy powder charge and dummy projectile when dummy ammunition is used.
No. 2 (breech detail).	Procures the operating crank for the breech mechanism and places it in position; procures cotton waste; takes post 1 yard to the rear and left of the breech, facing it.	(*a*) Cleans and oils the breech recess and gas check seat. (*b*) No duties.	No duties.	Opens the breech and assists in ramming the projectile and powder charge. After each shot, wipes off the mushroom head, gas check seat, and breech threads; assists in sponging the chamber.	Opens the breechblock, if so directed. Cleans the breech recess and gas check seat. Assists in withdrawing the dummy powder charge and dummy projectile when dummy ammunition is used.
No. 3 (breech detail).	Procures lanyard (if to be used), primer pouch, primers, punch, drill, reamer, and firing mechanism; takes post on the right side of the piece, about 1 foot to the right and in front of the elevating band, facing to the rear.	(*a*) Examines vent and firing mechanism; cleans the vent and primer seat; places the firing mechanism in position and coils the long lanyard (if used) and hangs it over the end of the elevating arm. (*b*) No duties.	No duties.	Inserts a primer after the breechblock has been closed and locked, and the lanyard hooked (if used); lowers the leaf of the firing device completely down and steps back to the right rear as the gun goes into battery. If the firing is by lanyard, lets the lanyard uncoil as the gun goes into battery, pulls it at the command FIRE; then coils the long lanyard and hangs it in the proper place. As soon as the breech is open after the piece has been fired, removes the old primer, clears the vent, and cleans the primer seat.	Removes the primer when so directed.

TABLE IV.—*Drill table—Service of the piece, 10-inch gun (disappearing carriage)*—Continued

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
No. 4 (breech detail).	Procures the rammer and places it on its hooks near the rail. Procures the extractor for the dummy projectile and places it near the rammer. Takes post about 2 yards from the head of the rammer, within reach of its staff, facing the piece.	(*a*) Assists the breech detail in cleaning. (*b*) No duties.	No duties.	Assists in ramming the projectile and powder. After ramming, replaces the rammer on the hooks.	When dummay ammunition is used, brings up the extractor, and pulls the dummy powder sections back upon the powder tray. Hooks the extractor into the dummy projectile and assists in withdrawing it.
Nos. 5 and 6 (elevating detail).	Take post at the elevating handwheel on the same side of the carriage as the range setter, facing the piece.	(*a*) Assist the range setter in examining the elevating and retracting mechanism and in cleaning and oiling the gears. (*b*) No duties.	See note 2.	Elevate or depress the piece under the direction of the range setter.	No duties.
Nos. 7 and 8 (traversing detail).	Procure the traversing cranks, place them on the traversing shaft, and take post facing to the rear at the crank on the same side of the carriage as the gun pointer.	(*a*) Remove the drip pans, and examine, test, clean, and oil the traversing mechanism under the supervision of the gun pointer. No. 8 receives the muzzle cover from No. 11 and places it in the designated place. (*b*) No duties.	See note 1.	They stop traversing while the piece is being loaded, and resume traversing, under the direction of the gun pointer, as soon as the loading operations are completed. They halt when the piece is fired.	No duties.
Nos. 9 and 10 (tripping detail).	No. 9 procures a wrench for filling plugs, a measure containing recoil oil, and a funnel; places them in a convenient place and goes to the right tripping lever, facing it. No. 10 procures a	(*a*) Examine the recoil cylinders and fill if necessary. After inspection of the cylinders by the gun commander, Nos. 9 and 10 screw the filling plugs well home and take posts.	No duties.	Assist in ramming the projectile. As soon as the projectile is seated, they quit the rammer and run to the tripping levers. At the command IN BATTERY, they seize the tripping levers, and at the command TRIP, raise them	When dummy ammunition is used, they assist in starting the projectile from its seat.

	wrench for filling plugs and takes post at the left tripping lever, facing it.	(*b*) No duties.		quickly to the stops, hold them for an instant, then let go. When the gun is in battery, they run back to their posts at the rammer, where they stand by for the next shot. If firing by electricity, No. 9 (or 10) closes the safety firing switch as soon as the gun is in battery.	
Nos. 11 and 12 (truck detail).	Bring out the shot trucks to be used and take post at the trucks, No. 11 on the right and No. 12 on the left.	(*a*) No. 11 removes the muzzle cover, hands it to No. 8, and assists No. 9 in filling the recoil cylinders, passing up the oil measure and funnel when needed. Nos. 11 and 12 examine the trucks, clean and oil them when necessary, and turn them over to the ammunition squad for loading. (*b*) No duties.	See note 3.	Run the loaded truck forward so that the tray enters the breech recess squarely. When the truck is stopped by the face of the breech, No. 12 sets the brake. After the projectile has been pushed off the truck, they withdraw the truck and turn it over to the ammunition squad. They then take post behind a loaded truck and stand by for the next shot.	When dummy ammunition is used, they push a truck into position at the breech to receive the dummy projectile. As soon as the truck is loaded, they return it to its position in rear of the breech.
Nos. 13, 14, 15, and 16 (powder serving detail).	Take post at a point on the loading platform most convenient for receiving the powder charge from the ammunition squad.	(*a*) As soon as the ammunition is served by the ammunition squad, they take post opposite the first loaded tray, Nos. 13 and 15 on the right, Nos. 14 and 16 on the left; Nos. 13 and 14 in the rear; No. 13 sees that the powder sections are arranged in the order in which they are to be inserted. During drill, when no ammunition is being served, the detail stands by the empty tray. (*b*) No duties.	No duties.	As soon as the rammer has been withdrawn after seating the projectile, the nose of the powder tray is inserted in the breech by the powder serving detail; the rammer detail pushes the powder charge off the tray into the chamber. The tray is then removed and turned over to the ammunition squad for refilling.	When dummy ammunition is used, they bring up the empty powder tray to receive the dummy powder sections and return the loaded tray to a convenient point.

TABLE IV.—*Drill table—Service of the piece, 10-inch gun (disappearing carriage)*—Continued.

Details	DETAILS, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
No 17 (sponge detail).	Procures the chamber sponge and a vessel containing liquid for sponging, places them near the railing at a convenient distance from the rammer, and takes post near the chamber sponge, facing the gun.	(*a*) Brings up the chamber sponge when called for and assists in sponging the chamber. (*b*) No duties.	No duties.	Dips the chamber sponge in the liquid for sponging and allows the excess liquid to run off. As soon as the breech is opened after each shot, assisted by the breech detail, he sponges the chamber as quickly as possible.	No duties.

NOTES

1. At the command TARGET, in case II firing, the gun pointer sets on the sight the deflection recorded on the display board; Nos. 7 and 8 traverse the piece under the direction of the gun pointer until the line of sight is on the target; the gun pointer calls "On target"; they continue to follow the target. In case III firing, the gun pointer directs Nos. 7 and 8 to traverse the piece so that the azimuth index is set to the azimuth posted on the display board; the gun pointer calls "On target"; they continue to traverse the piece to data recorded on the display board.

2. At the command TARGET the range setter, assisted by Nos. 5 and 6, points the piece in range continuously according to information obtained from the display board.

3. At the command TARGET, Nos. 11 and 12 push the first loaded truck to some convenient position in rear of the breech.

Section VI

12- AND 14-INCH DISAPPEARING GUNS

15. Notes on drill.—*Q*. What is the formation for the gun section of 12- and 14-inch guns on disappearing carriages? *A*. See figure 9.

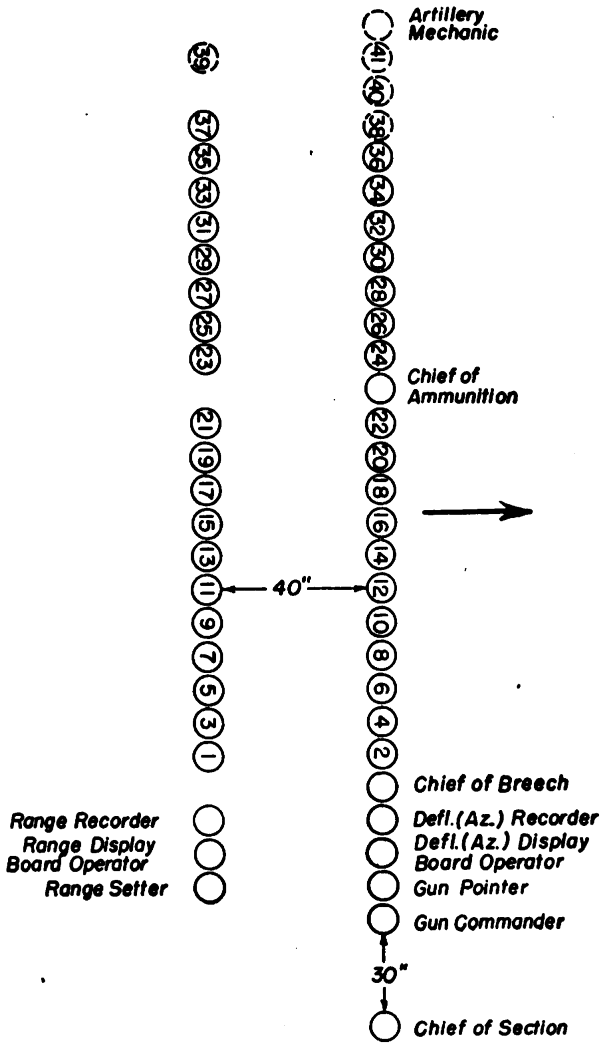


FIGURE 9.—Formation of gun section for 12- and 14-inch guns on disappearing carriages.

Q. What are the posts of the gun squad of the 12- and 14-inch guns on disappearing carriages? *A*. See figure 10.

Q. What duties must No. 3 perform to insure proper operation of the firing mechanism? *A*.

(1) Before firing, No. 3 assembles firing mechanism to the gun and sees that vent is clear and that primer seat is clean and unpitted.

He sees that firing leaf cannot be drawn back until slide has been closed and breechblock closed and locked.

(2) In firing, the chief of breech hooks lanyard (if used) and No. 3 inserts a primer after breechblock is closed and locked. No. 3 com-

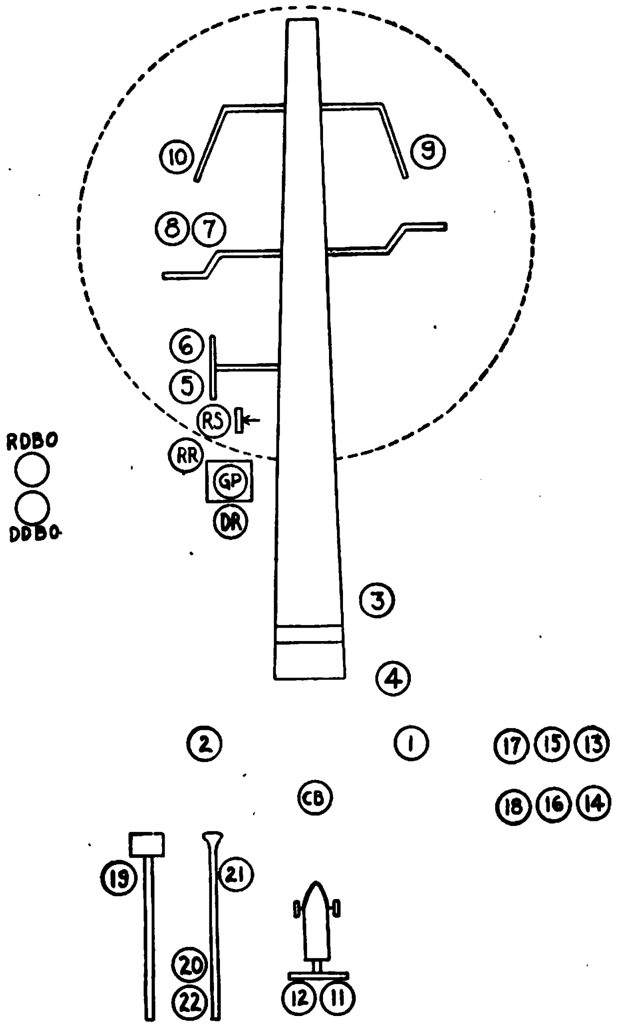


FIGURE 10.—Posts of gun squad for 12- and 14-inch guns on disappearing carriages.

pletely closes slide of the firing mechanism before attempting to fire the gun, otherwise the primer may be blown to the rear endangering the gun squad. After the gun has been fired, the chief of breech unhooks lanyard, and as soon as the breech is open No. 3 removes fired primer.

(3) It is of great importance that No. 3 clean primer seat and vent after each shot, for when a primer sticks it is usually due to powder residue having collected between the primer and the primer seat or vent or the primer seat having become pitted. A fired primer that

has become stuck may be removed by using a drift through the vent at the same time opening the firing mechanism slide.

Q. Describe the operation of the breech mechanism. *A*.

(1) *Breech mechanism 1895.*—(*a*) The service of the piece as given in drill table (table V) is for a gun fitted with an M1895 breech methanism.

1. *To open.*—The chief of breech unhooks lanyard (if used) from eye of firing leaf; No. 4 turns crank continuously in a clockwise direction until tray comes to rest against hinge plate.
2. *To close.*—No. 4 turns crank in a counterclockwise direction until projecting shoulder on rotating lug striking the gear prevents further motion.

(*b*) It will be found convenient to fasten a wire around the piece back of the elevating band. This wire should have a loop in it in which the safety lanyard (if used) may be hooked during the loading. The chief of breech after unhooking the lanyard swings it over the teeth of the breech mechanism and hooks it in the loop of the wire. Thus it is kept from being caught in the mechanism and is convenient to the chief of breech when the time comes to hook it again.

(2) *Breech mechanism M1888.*—If the gun is fitted with an M1888 breech mechanism the duties of Nos 1 and 2 are changed.

(*a*) *To open.*—No. 2 releases rotating crank by turning wing nut of catch to the left and then turns rotating crank clockwise as indicated by the "open" arrow until it is stopped in a horizontal position and is secured by its catch; No. 1 turns translating crank briskly counterclockwise. When the shoulders of the grooves strike against the ends of the rails, the block stops short and the shock frees the tray latch from its catch; No. 1 swings tray and block to the right until securing latch engages in catch.

(*b*) *To close.*—No. 2 releases securing latch from its catch; No. 1 swings tray and block around to the left smartly; No. 2 seizes handle of tray and continues swinging of block until tray butts against and is latched to face of breech; then he turns translating crank clockwise until breech is translated completely; No. 1 releases rotating crank by turning wing nut and turns rotating crank counterclockwise, as indicated by the "close" arrow, until it is stopped in a vertical position and is secured by its catch.

Q. How are the 12- and 14-inch guns (disappearing carriages) loaded? *A*.

(1) At the command LOAD, the breech is opened and the truck detail moves the truck up to face the breech. Nos. 1, 2, 9, 10, 20, 21, and 22 man rammer as near the outer end as possible. Nos. 21, 1, and 9 are on the right of the rammer and Nos. 2, 10, 20, and 22 are on the left, in order named, from the head of the rammer to the rear. The chief of breech also assists on the right side of the rammer. No. 21 places head of rammer against base of projectile. As soon as the truck is brought up against the face of the breech, No. 12 sets brake. At the command HOME, given by the chief of breech, the men on the rammer carefully push projectile off truck. At the command RAM, given by the chief of breech as soon as the base of the projectile is just inside the powder chamber, the projectile is pushed forward until it is seated. The projectile is rushed forward in one motion at increasing speed so that it will have its fastest movement when it comes up hard against its seat. The truck is withdrawn and run off to one side. Nos 9 and 10 quit rammer for tripping levers. Nos. 1, 2, 20, 21, and 22 move back far enough so that the powder-serving detail can place the nose of the powder tray in the breech recess. No. 21 places head of rammer against base of powder charge, and at the command RAM, given by the chief of breech, the men on the rammer push powder into powder chamber to such distance that the breechblock in closing will give the powder a final push into the chamber. Nos. 20, 21, and 22 carry rammer back to position preparatory to ramming the next round.

(2) An alternate method of powder service may be employed in batteries where the shot trucks are equipped with powder trays. In such cases a shot truck is loaded with a projectile by the projectile detail and then with a powder charge by the powder detail. The truck detail takes the completely loaded shot truck to the gun. After the truck is run up to the breech, the rammer detail rams the projectile and then the powder directly from the shot truck. The empty truck is withdrawn and turned over to the projectile detail.

Q. How is the gun tripped into battery? *A.*

(1) The gun is held from battery by the engagement of pawls with the teeth in the cross head which prevents the counterweight from descending. Raising the tripping levers releases the pawls from the cross head teeth enabling the counterweight to descend and the gun to rise into battery, while safety latches retain the pawls clear of the descending cross head teeth. At the command IN BATTERY, Nos. 9 and 10 seize the tripping levers, and at the command TRIP, raise them quickly to the full limit of upward movement. A slight downward movement on the tripping levers will indicate if the safety latches have engaged.

(2) If the gun fails to go completely into battery, the gun commander orders Nos. 4, 9, 10, and 20 to use the pinch bars. These are engaged in the notches on the chassis and the gun is forced into battery. Failure of the gun to go completely into battery will be immediately reported to the battery commander in order that the necessary action may be taken.

Q. How is the gun retracted? *A*.

(1) *By hand*.—(*a*) At the command FROM BATTERY, given by the gun commander, No. 7 releases retaining pawl and turns speed crank to permit pulling out of cables. Nos 3 and 4 mount chassis and Nos. 9 and 10 mount gun levers. Nos. 1 and 2 pull out cables to their full length and pass the ends to Nos. 3 and 4, who pass them to Nos. 9 and 10, who place the ends of cables on hooks. No. 7 then throws on retaining pawl and turns speed crank to take up all slack. No. 8 pushes in clutch; Nos. 3 and 4 watch cables to see that they take the grooves of the drums. As soon as the slack has been taken up, Nos. 3, 4, 9, and 10 return to loading platform, and Nos. 7 and 8 put on retraction cranks.

(*b*) The gun squad is divided into two reliefs by the gun commander. The first relief takes post at the retraction cranks and at the command HEAVE starts to retract the gun. The reliefs alternate as directed by the gun commander. Care is taken to see that the cables are under equal tension and are guided to the pulleys without kinks. As soon as the cross head teeth engage their pawls, the retraction shaft retaining pawl is thrown off and remains off until the cables have been unhooked from the gun levers.

(*c*) The gun commander designates a cannoneer to call off the notches of recoil indicated by the engagement of the pawl teeth with the cross head teeth. When the gun has reached the loading position, the gun commander commands: HALT. At this command Nos. 7 and 8 remove retraction cranks. No. 7, using speed crank, lets out enough slack to enable Nos. 1 and 2 to unhook cables. After the cables are unhooked, No. 7 takes up all slack with speed crank and then throws retaining pawl on. No. 8 then pulls out clutch.

(2) *By power*.—Assuming the idler to be out of gear, the cables to be hooked to the gun levers, the slack taken out by No. 7, and the clutch thrown in by No. 8, at the command HEAVE, given by the gun commander, No. 8 throws the idler in gear. As soon as this is done, the range setter closes the main switch of the controller cabinet and moves the arm so as to turn on the power. The movements at the command HALT are the same as those prescribed for hand retraction, except that the range setter pulls the main switch of the controller

cabinet, after which No. 8 throws the idler out of gear. The cables are then unhooked and the slack taken up as prescribed for hand retraction.

NOTE.—On carriages equipped with friction brakes on the retraction crank shaft, it is not necessary to unhook the cables from the gun levers, and the drill may be modified accordingly.

Q. How are shot trucks adjusted? *A*. Before firing, shot trucks are adjusted to the highest point to which it is anticipated that the gun will recoil, since a downward adjustment is much more easily and rapidly made than an upward one. Marks corresponding to "notches of recoil" may be placed on the shot trucks to facilitate loading after the first round has been fired.

16. Drill table.—*Q*. What are the duties of the members of the gun section for 12- and 14-inch guns on disappearing carriages? *A*. See table V.

TABLE V.—*Drill table—Service of the piece, 12- and 14-inch guns (disappearing carriage)*

Details	DETAILS, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Gun pointer.	Procures sight, places it in its seat, and takes post on gun pointer's platform.	(*a*) Examines sight and verifies adjustment of azimuth index; examines traversing mechanism and electric firing circuit. (*b*) Reports to gun commander, "Traversing in order," or defects he is unable to remedy.	See note 1	Keeps piece pointed in direction. In case II firing, repeats to deflection recorder data he sets on sight; fires piece or commands: FIRE, as soon after the gun commander has called or signaled "Ready" as piece is pointed. When so directed, endeavors to locate splash of shot and corrects his deflection, if necessary. In case III firing, sets azimuth index to azimuth posted on display board and calls "Azimuth set."	Keeps piece pointed in direction until command CEASE TRACKING is received.
Range setter.	Takes post facing range scale.	(*a*) Examines range scale and elevating and retracting mechanisms; assisted by Nos. 5 and 6, cleans and oils gears. (*b*) Reports to gun commander, "Elevation and retraction in order," or defects he is unable to remedy.	See note 2.	Lays piece in range; calls "Range set."	Keeps piece laid in range until command CEASE TRACKING is received.

TABLE V.—*Drill table—Service of the piece, 12- and 14-inch guns*—Continued

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Chief of breech.	Posts his detail after assuring himself that each man has procured necessary cleaning material and equipment; takes post 2 yards in rear of breech, facing it.	(*a*) Examines breech mechanism, breechblock, breech recess, chamber and bore, and gives necessary orders for cleaning and putting them in condition for service. (*b*) Reports to gun commander, "Breech in order," or defects he is unable to remedy.	No duties.	Gives command: 1. HOME, 2. RAM, for ramming projectile. At the command HOME the projectile is pushed off truck, and RAM is given when base of projectile is just inside powder chamber; gives command RAM for ramming powder charge, assisting on rammer for both operations. After breechblock has been closed, hooks lanyard (if used) to firing leaf. After primer has been inserted and firing leaf completely lowered, commands: 1. IN BATTERY, 2. TRIP. After piece has been fired, unhooks lanyard.	Supervises unloading when dummy ammunition is used.
No. 1 (breech detail).	Procures cotton waste, can containing lubricating oil, and wiper, places them in a convenient place, and takes post 1 yard to rear and right of breech, facing it.	(*a*) Assisted by No. 4 removes breech cover and places it at the designated place; cleans and oils breechblock and breech mechanism. (*b*) No duties.	No duties.	Assists in ramming projectile and powder charge; assists No. 4 in closing breech. After each shot, assists No. 19 in sponging chamber.	When dummy ammunition is used, hooks dummy extractor in base of dummy powder charge and assists in withdrawing charge; in similar manner, assists in removing dummy projectile.
No. 2 (breech detail).	Procures cotton waste and takes post 1 yard to rear and left of breech, facing it.	(*a*) Cleans and oils breech recess and gas check seat. (*b*) No duties.	No duties.	Assists in ramming projectile and powder charge; assists No. 4 in closing breech. After each shot, assists No. 19 in sponging chamber and wipes off mushroom head, gas check seat, and breech recess.	When dummy ammunition is used, assists in withdrawing dummy powder charge and dummy projectile.

No. 3 (breech detail).	Procures lanyard (if used), primer pouch, primers, punch, drill, reamer, and firing mechanism, and takes post on right side of piece, 1 foot to right and in front of elevating band, facing to rear.	(a) Examines vent and firing mechanism; clears vent and cleans primer seat; places firing mechanism in position; coils lanyard (if used) and hangs it over elevating arm. (b) No duties.	No duties.	Inserts primer after breechblock has been closed and locked and lanyard (if used) hooked; completely lowers leaf of firing device and steps to right rear as gun goes into battery. If firing is by lanyard, lets lanyard uncoil as piece goes into battery, pulls it at command FIRE, and then coils long lanyard and hangs it in the proper place. As soon as breechblock has been opened after piece has been fired, removes old primer, clears vent, and cleans primer seat.	Removes primer when so directed.
No. 4 (breech detail).	Procures operating crank for breech mechanism, places it in position, and takes post 2 feet to right of breech, on line with its face, facing it.	(a) Assists No. 1 in removing breech cover and placing it in its designated place. Assists in cleaning and oiling breechblock and breech mechanism. (b) No duties.	No duties.	Opens breech and holds breechblock until chief of breech commands: CLOSE BREECH; close breech, assisted by Nos. 1 and 2.	When dummy ammunition is used, opens breech and holds breechblock until dummy powder charge and projectile have been removed.
Nos. 5 and 6 (elevating detail).	Take post at elevating handwheel, on same side as range setter, facing piece.	(a) Assist range setter in examining elevating and retracting mechanisms and in cleaning and oiling gears. (b) No duties.	See note 2.	Elevate piece as directed by range setter.	No duties.
Nos. 7 and 8 (traversing detail).	Procure traversing cranks, place them on traversing shaft, and take post facing to rear at crank on same side of carriage as gun pointer.	(a) Remove drip pan and examine, test, clean, and oil traversing mechanism under supervision of gun pointer. No. 8 receives muzzle cover from No. 21 and places it in designated place. (b) No duties.	See note 1.	Traverse piece as directed by gun pointer. They halt when piece is fired and resume traversing as soon as loading operations are completed.	No duties.

TABLE V.—*Drill table—Service of the piece, 12- and 14-inch guns*—Continued

Details	DETAIL, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
(Nos. 9 and 10 tripping detail).	No. 9 procures wrench for filling plugs, measure containing recoil oil, and funnel, places them in a convenient place, and takes post at right tripping lever, facing it. No. 10 procures wrench for filling plugs and takes post at left tripping lever, facing it.	(a) Examine recoil and buffer cylinders, and assisted by No. 22 fill them if necessary. After inspection of cylinders by gun commander, No. 9 takes post on right of rammer about 2 feet from rear end, and No. 10 takes post on left of rammer in front of No. 20. (b) No duties.	No duties.	Assist in ramming projectile. As soon as projectile is seated, they quit rammer and run to tripping levers. At command IN BATTERY, they seize tripping levers, and at command TRIP raise them quickly to stops, hold them there for an instant, releasing them slightly to test engagement of safety catch, and then let go. When gun is in battery, they run back to their posts on rammer in preparation for next round. If firing is by electricity, No. 10 closes safety firing switch as soon as gun is in battery.	When dummy ammunition is used, they assist in starting dummy projectile from its seat.
Nos. 11 and 12 (truck detail).	Bring out shot trucks to be used and take post at handles of one of trucks. No. 11 on right and No. 12 on left.	(a) Examine and adjust trucks; clean and oil them if necessary, after which they turn them over to the ammunition squad for loading. (b) No duties.	See note 3.	Run loaded truck forward so that tray enters breech recess squarely. As truck hits face of breech No. 12 sets brake. After projectile has been pushed off truck, the detail withdraws truck and turns it over to ammunition squad; then takes post behind loaded truck in preparation for next round.	When dummy ammunition is used, they push truck into position at breech to receive dummy projectile. As soon as truck is loaded, they return it to loading position.
Nos. 13, 14, 15, 16, 17, and 18 (powder serving detail).	Take post convenient for receiving powder charges from ammunition squad. When dummy ammunition is used, the detail takes post at tray containing dummy powder charge, Nos. 17, 15, and 13 on right, and Nos. 18, 16, and 14 on left, in order named from front to rear.	(a) Examine powder trays and turn them over to ammunition squad for loading. (b) No duties.	No duties.	No. 13 sees that powder sections are arranged in order in which they are to be inserted. As soon as rammer has been withdrawn after seating projectile, the detail carries powder tray to breech and inserts nose in breech recess. The rammer detail pushes powder off the tray into powder chamber. The tray is then removed and turned over to ammunition squad for refilling.	When dummy ammunition is used, they bring up empty powder tray to receive dummy powder sections and return loaded tray to a convenient point.

No. 19 (sponge detail).	Procures chamber sponge and vessel containing liquid for sponging, places them at a convenient distance from rammer, and takes post near sponge, facing gun.	(*a*) Brings up chamber sponge when called for by chief of breech and assists in sponging chamber. (*b*) No duties.	No duties.	Dips sponge in liquid for sponging and allows excess liquid to run off. As soon as breech is open after each shot; assisted by Nos. 1 and 2 sponges chamber as quickly as practicable.	No duties.
Nos. 20, 21, and 22 (rammer detail).	Nos. 20 and 21 procure rammer and place it on emplacement, in rear of and to one side of gun, at convenient point for ramming. No. 20 takes post on left of and about 3 feet from rear end of rammer. No. 21 takes post on right, 4 feet from head of rammer. No. 22 procures extractor for dummy projectile, places it on rack, and takes post on left of rear and of rammer. All face to front.	(*a*) No. 20 assists breech detail if called upon. No. 21 passes around right of carriage, mounts to muzzle and removes muzzle cover, handing it to No. 8. No. 22 passes around left of carriage and assists tripping detail in filling recoil and buffer cylinders. The detail returns to its post on rammer. (*b*) No duties.	No duties.	As truck is brought up to face of breech, rammer detail, assisted by chief of breech and Nos. 1, 2, 9, and 10, rams projectile. After powder serving detail places nose of powder tray in breech recess, rammer detail, assisted by Nos. 1 and 2, rams the powder. Rammer detail then carries rammer back to position preparatory to ramming next round.	When dummy ammunition is used, No. 22 brings dummy extractor and No. 1 hooks it in base of dummy powder charge. Rammer detail assisted by Nos. 1 and 2, then withdraws dummy powder charge. The dummy projectile is removed in a similar manner.

NOTES

1. At the command TARGET, gun pointer in case II firing sets on sight the deflection recorded on display board; Nos. 7 and 8 traverse piece under direction of gun pointer so that line of sight is on target; the gun pointer calls "On target"; gun pointer continues to set data posted on display board, and assisted by Nos. 7 and 8 follows the target. In case III firing Nos. 7 and 8, under direction of gun pointer, traverse gun so that azimuth index is set to azimuth posted on display board, gun pointer calls "Azimuth set"; gun pointer assisted by Nos. 7 and 8 continues to traverse gun according to data posted on display board.

2. At the command TARGET, range setter, assisted by Nos. 5 and 6, points piece in range continuously according to data posted on the display board.

3. At the command TARGET, truck detail runs first loaded truck to convenient position in rear of breech.

Section VII

12-INCH BARBETTE GUN

17. Notes on drill.—*Q.* What is the formation for the gun section of the 12-inch gun on barbette carriage? *A.* See figure 11.

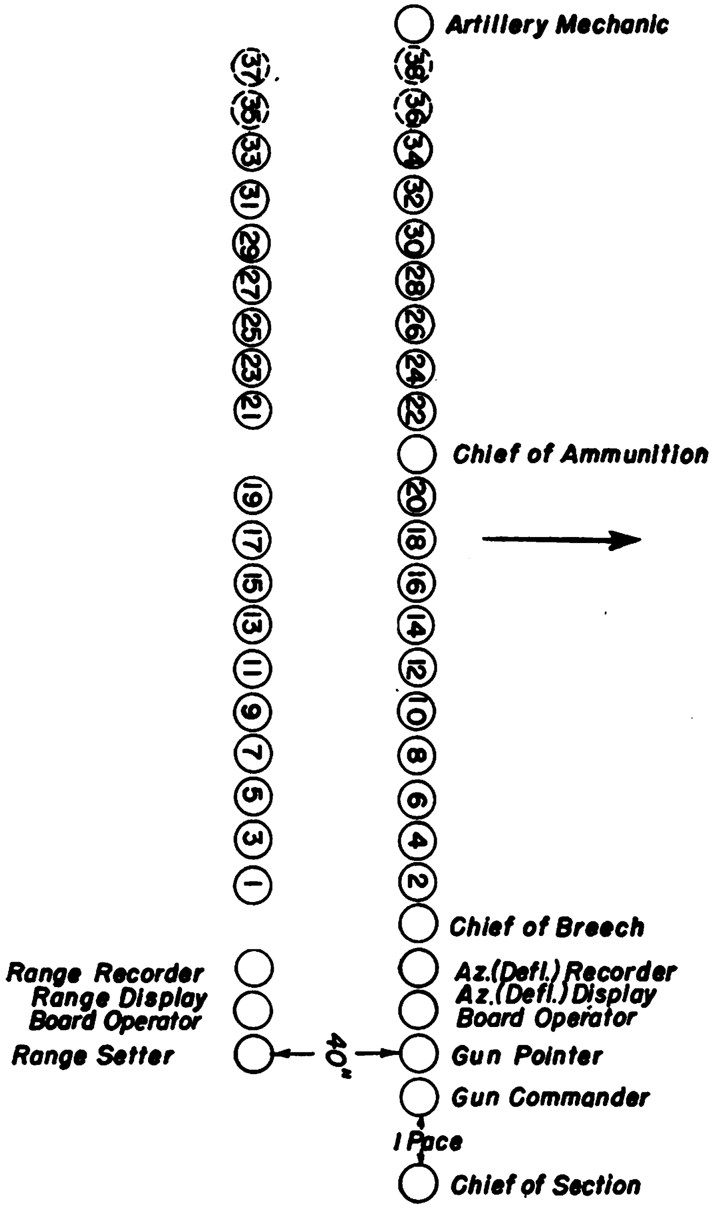


FIGURE 11. Formation of gun section for 12-inch gun on barbette carriage.

Q. What are the posts of the gun squad of the 12-inch gun on barbette carriage? *A.* See figure 12.

Q. How is the firing mechanism, M1903, assembled to the gun? *A.*
(1) Clasp the hinged collar over the end of the spindle with the two ribs of the collar engaging in the corresponding grooves of the spindle, keeping the hinge at the top.

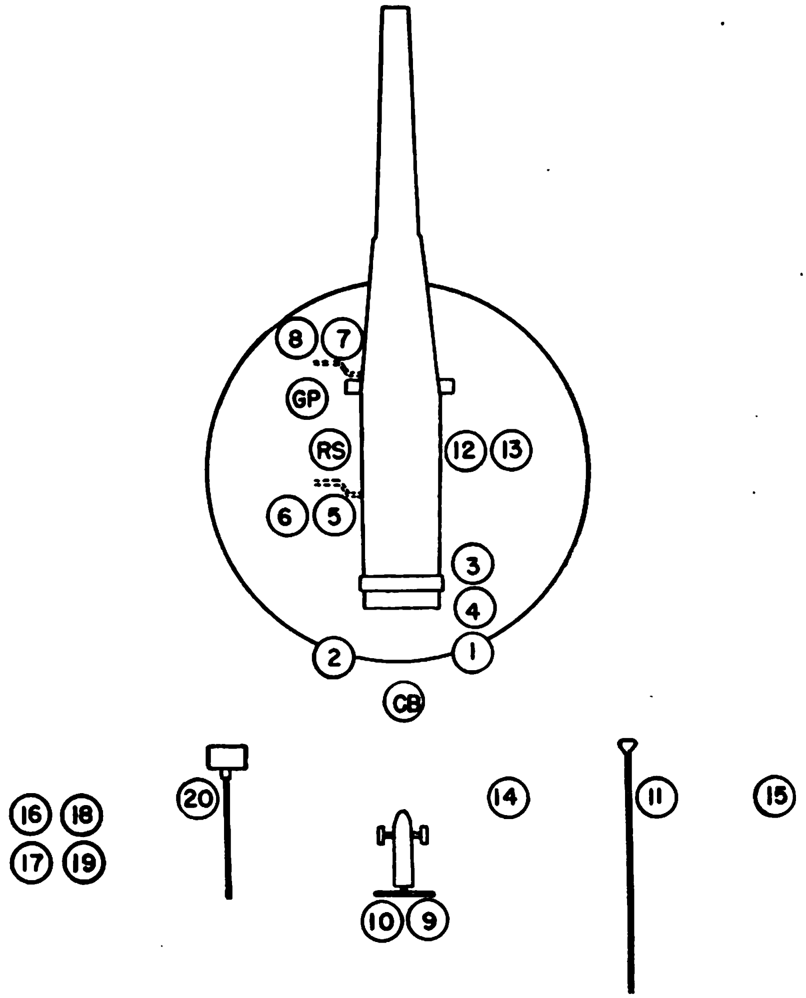


FIGURE 12.—Posts of gun squad for 12-inch gun on barbette carriage.

(2) Take the mechanism in the right hand, holding the collar with the left, and put the mechanism over the end of the collar. Screw the collar to the left until the catch on the under side of the mechanism engages and locks it in position. While doing this, see that guide bar which projects from the right side of the mechanism enters the groove cut in the breechblock for it and that the pin on the safety bar slide (which is attached to the gun) enters the hole in the outer end of the safety bar of the mechanism. *Do not attempt to use the*

mechanism until it is absolutely certain that the collar has been screwed entirely home and locked.

(3) After the primer has been inserted, lower the slide until the catch engages in the notch of the housing. *Be sure the slide is entirely down before attempting to fire the piece*, otherwise the primer may be blown to the rear and endanger members of the gun squad.

Q. How is the firing mechanism removed from the gun? *A*. Draw the collar catch to the rear and unscrew the hinged collar.

Q. What are the safety features of the firing mechanism M1903? *A*.

(1) There is a safety lug on the right side of the housing which prevents the firing leaf from being drawn back until the slide is all the way down.

(2) There is also a safety bar which holds the firing leaf until it is withdrawn by the safety bar slide, actuated by the rotation of the block.

Q. Describe the operation of the breech mechanism. *A*.

(1) *Breech mechanism M1895.*—(*a*) *To open.*—The chief of breech unhooks the lanyard (when one is used) from the eye of the firing leaf, and No. 4 unlocks the breechblock and turns the crank continuously in a clockwise direction until the tray comes to a rest against the hinge.

(*b*) *To close.*—No. 4 turns the crank in a counterclockwise direction until the breechblock is fully translated, rotated, and locked in the closed position.

(*c*) It will be found convenient to fasten a wire around the piece back of the elevating band. This wire should have a loop in it in which the safety lanyard (if one is used) may be hooked during the loading. The chief of breech after unhooking the lanyard swings it over the teeth of the breech mechanism, and hooks it in the loop of wire. Thus it is kept from being caught in the mechanism and is convenient to the chief of breech when the time comes to hook it again.

(2) *Breech mechanism M1888.*—(*a*) *To open.*—No. 2 releases the rotating crank by turning the wing nut of the catch to the left and then turns the rotating crank clockwise as indicated by the "open" arrow until it is stopped in a horizontal position and is secured by its catch; No. 1 turns the translating crank briskly counterclockwise. When the shoulders of the grooves strike against the ends of the rails the block stops short and the shock frees the tray latch from its catch; No. 1 swings the tray and block to the right until the securing latch engages in the catch.

(*b*) *To close.*—No. 2 releases the securing latch from its catch; No. 1 swings the tray and block around to the left smartly; No. 2 seizes the handle of the tray and continues the swinging of the block until the tray butts against and is latched to the face of the breech, then he turns the translating crank clockwise until the breech is translated completely; No. 1 releases the rotating crank by turning the wing nut and turns the rotating crank counterclockwise as indicated by the "close" arrow until it is stopped in a vertical position and is secured by its catch.

Q. How is the gun loaded? *A.*

(1) *Normal method.*—At the command LOAD, the breech is opened and the truck brought up to the face of the breech at a fast walk. *The truck must not be brought up at a run since this will cause the buffer on the front of the truck to be damaged when the shot truck strikes the breech.* Nos. 11, 12, 13, 14, and 15, assisted by the chief of breech and Nos. 1 and 2, man the rammer as near the outer end as possible, Nos. 1, 11, 13, and 15 on the right side of the rammer, and Nos. 2, 12, 14, and the chief of breech on the left side, in the order named from the head to the rear of the rammer. As the shot truck passes the rammer detail, No. 1 places the head of the rammer against the base of the projectile and the rammer detail then follows up the shot truck with the rammer. Just before the shot truck strikes the face of the breech, the chief of breech commands: HOME. When the chief of breech hears the buffer on the shot truck strike the breech face, he commands: RAM. At the command RAM, the rammer detail pushes the projectile off the truck and into the breech, gaining increased momentum until the projectile comes up hard in its seat. The ramming detail then moves back far enough to permit the powder-serving detail to put the powder (on the shot truck or on a separate powder tray) in position for ramming. No. 1 places the head of the rammer against the base of the powder charge, and at the command RAM, given by the chief of breech, the ramming detail pushes the powder off the tray (or truck) and into the powder chamber to such a distance that the breechblock in closing will give the powder a final push into the chamber. Nos. 11, 12, and 13 then carry the rammer back to position preparatory to ramming the next shot.

(2) *Alternate method.*—Where a short rammer or arrangement of the emplacement makes it impossible to obtain a satisfactory ram while the shot truck is in position at the breech, an alternate method of loading may be desirable. In this method the rammer is manned as in the normal method. As soon as the shot truck is brought

up to the face of the breech, No. 1 places the head of the rammer against the base of the projectile. The rammer detail carefully pushes the projectile off the truck until its base is just inside the powder chamber. The truck is then withdrawn and run off to one side. At the command 1, HOME, 2. RAM, given by the chief of breech, the rammer detail rushes the projectile forward into its seat, increasing the speed of the rush so that the projectile will have its fastest movement when it comes up hard into its seat. The remainder of the loading operation is the same as in the normal method.

Q. Describe the method of simulating fire during drill in which dummy ammunition is used. *A*.

(1) (*a*) For the first and succeeding odd-numbered rounds, the operations of loading, pointing, and firing are as given above for service ammunition.

(*b*) For the second and succeeding even-numbered rounds, the operations of sponging and loading are omitted, and the operation of unloading is substituted therefor. As soon as the projectile is removed, No. 4 closes the breech and the operations of pointing and firing proceed as for service ammunition.

(2) Unusual events such as misfires which may occur during actual firing should be simulated during the drill. They should be called by the executive or chief of section without prior information to the gun squad and in such a manner as to inject realism into the drill.

18. Drill table.—*Q*. What are the duties of the members of the gun section for the 12-inch gun on barbette carriage? *A*. See table VI.

TABLE VI.—*Drill table—Service of the piece, 12-inch gun (barbette carriage)*

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Gun pointer (noncommissioned officer).	If the sight is to be used, gets the telescopic sight, places it on the sight standard, and takes position in rear of the sight, facing it. If the azimuth circle is to be used he takes position there he can see the azimuth pointer.	(*a*) Examines sight and verifies adjustment of azimuth index; supervises the work of Nos. 7 and 8 in examining and testing the traversing mechanism. If used, examines magneto and electric circuit. (*b*) Reports to the gun commander, "Traversing (and firing circuit) in order," or any defects that he is unable to remedy without delay.	See note 2	Sets on his sight deflection recorded on display board; and assisted by Nos. 7 and 8, traverses the gun without interfering with loading until the line of sight is on the target; fires piece or gives command: FIRE, as soon after gun commander has called or signaled "Ready" as piece is pointed; when directed, endeavors to locate position of splash of his shot and corrects deflection if necessary. When firing by case III, he sets azimuth index to azimutn sent from plotting room and calls or signals "Azimuth set."	Continues setting data until CEASE TRACKING is received. (See note 4.)
Range setter (noncommissioned officer).	Takes post facing the range scale.	(*a*) Examines the elevating mechanism; and assisted by Nos. 5 and 6, cleans and oils the gears if necessary. (*b*) Reports to the gun commander, "Elevation in order," or any defects he is unable to remedy without delay.	No duties	Waits for the command ELEVATE; assisted by Nos. 5 and 6, points the piece for the range recorded on display board, then calls "Range set." He causes the piece to be brought to the loading position after each shot.	Assisted by Nos. 5 and 6, depresses piece to loading position. (See note 4.)

TABLE VI.—*Drill table—Service of the piece, 12-inch gun (barbette carriage)*—Continued

Details	DETAILS, POST	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Chief of breech (noncommissioned officer).	Posts his detail after assuring himself that each man has procured the necessary cleaning material and equipment. He then takes post 2 paces in rear of the breech, facing it.	(*a*) Examines the breech mechanism, breechblock, breech recess, chamber, and bore (paying special attention to the safety devices), and supervises the breech detail in the work of cleaning and putting matériel in condition for firing. (*b*) Reports to the gun commander, "Breech mechanism in order," or any defects he is unable to remedy without delay.	No duties	Supervises the work of his detail. Gives the command: 1. HOME, 2. RAM, for ramming the projectile, giving HOME as the truck approaches the face of the breech, and RAM as the truck strikes the face of the breech. (See note 3.) Also gives command RAM for ramming powder charge, assisting on rammer for both operations. After breechblock has been closed, he hooks lanyard (if used) to firing leaf before primer is inserted. After primer is inserted and firing leaf completely lowered, he commands: ELEVATE. After piece is fired he unhooks lanyard.	Supervises unloading if dummy ammunition is used.
No. 1 (breech detail).	Procures cotton waste, a can containing lubricating oil, and a sponge, and places them in a convenient place; takes post 1 yard to the rear and right of the breech, facing it.	(*a*) Assisted by No. 4 removes the breech cover and places it at the designated place. Assisted by No. 4, cleans and oils the breechblock and breech mechanism. (*b*) No duties.	No duties	Places the head of the rammer against the base of the projectile as the truck approaches the breech, and assists in ramming the projectile and powder; assists in closing breech if necessary. After each shot, assists No. 20 in sponging chamber.	When dummy ammunition is used, he assists in withdrawing dummy powder charge and projectile.
No. 2 (breech detail).	Procures cotton waste and takes post 1 yard to the rear and left of the breech, facing it.	(*a*) Cleans and oils breech recess and gas check seat. (*b*) No duties.	No duties	Assists in ramming and, if necessary, in closing breech. After each shot he assists No. 20 in sponging chamber and wipes off mushroom head, gas check seat, and breech recess with cotton waste moistened with light recoil oil.	Same as No. 1.

No. 3 (breech detail).	Procures a lanyard (if one is used), a primer pouch, primers, punch, drill, reamer, and the firing mechanism; and takes post on the right side of the piece, 2 feet to the right of the yoke, facing to the rear.	(*a*) Examines the vent and the firing mechanism, clears the vent, and cleans the primer seat; places the firing mechanism in position, coils the lanyard (if one is used), and places it in a convenient place. (*b*) No duties.	No duties...	Inserts a primer after the breechblock has been closed and rotated and the lanyard (if one is used) hooked, lowers the firing leaf of the firing device completely, and steps back to right rear. Uncoils the lanyard, pulls it at the command FIRE, and coils it again after the piece has been fired (if firing is by lanyard). As soon as breechblock is opened after firing, No. 3 removes old primer, clears vent, and cleans primer seat.	Removes the primer (See note 4.)
No. 4 (breech detail).	Procures the operating crank for the breech mechanism, places it in position, and takes post 2 feet to the right of the breech, on line with its face, facing it.	(*a*) Assists No. 1 in removing the breech cover and in cleaning, and oiling the breechblock and breech mechanism. (*b*) No duties.	No duties...	Opens the breech and holds the breechblock back until the powder charge is rammed. He then closes the breech, assisted by Nos. 1 and 2, if necessary.	When dummy ammunition is used, he opens breech and holds the breechblock back until the dummy powder charge and projectile have been removed. He then closes the breech.
Nos. 5 and 6 (elevating detail).	Take post at the elevating crank in the well on the same side as the gun pointer.	(*a*) Assist range setter in examining and testing the elevating mechanism and in cleaning and oiling the gears. (*b*) No duties.	No duties.	Elevate or depress the piece under the direction of the range setter.	Nos. 5 and 6 depress the piece to the loading position.
Nos. 7 and 8 (traversing detail).	Procure the traversing cranks, place one of them on the shaft on the same side as the gun pointer, and take post at the crank, facing to the rear.	(*a*) Remove the drip pans and examine, test, clean, and oil traversing mechanism under supervision of gun pointer. (*b*) No duties.	See note 2.	Traverse the piece under direction of the gun pointer. They halt when the piece is fired and resume traversing as soon as loading operation is completed. In firing by case III, No. 8 assists the recorder in addition to his other duties.	Traverse the piece under the direction of the gun pointer until CEASE TRACKING is received.

TABLE VI.—*Drill table—Service of the piece, 12-inch gun*—Continued.

Details	DETAILS, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Nos. 9 and 10 (truck detail).	Bring out shot trucks to be used and take post at the handles of one of them in rear of and in line with the piece, No. 9 on the right and No. 10 on the left.	(*a*) Examine, clean, and oil the trucks, after which they turn them over to the ammunition squad for loading. When the first truck is loaded they push it to a convenient position about 5 yards in rear of breech. (*b*) No duties.	No duties.	Move truck forward at a fast walk until tray enters breech recess squarely; as truck brings up against face of breech, No. 10 sets brake. As soon as projectile (and powder charge, if it is on truck) is rammed, they run the truck back and turn it over to ammunition squad. They then take posts behind a loaded truck and stand by for the next shot.	When dummy ammunition is used, they push truck into position at breech to receive dummy projectile. As soon as truck is loaded, they return it to loading position.
Nos. 11, 12, 13, 14, and 15 (rammer detail).	Nos. 11 and 14 procure rammer and place it on prop. No. 11 takes post about 2 yards from head of rammer, on right, within reach of staff, facing piece. 12 procures measure containing light recoil oil, and funnel, and goes to recoil cylinder. No. 13 procures wrench for filling plugs and goes to recoil cylinder. No. 14 takes post 4 yards to left of No. 11, facing piece. No. 15 procures extractor for dummy projectile, places it near rammer, and takes post 4 yards to right of No. 11, facing rammer.	(*a*) No. 11 assists breech detail. No. 13 removes filling plugs and attaches pipe and funnel, if oil is needed. No. 12 pours oil through funnel. When cylinder is full, No. 12 notifies gun commander that cylinder is ready for inspection. After inspection by gun commander, No. 13 screws plugs well home and takes post 3 yards to right of No. 11. No. 13 replaces funnel and measure and takes post 3 yards to left of No. 11. No. 14 removes muzzle cover and hands it to No. 15, who places it at designated place. (*b*) No duties.	No duties.	As truck is brought up to face of breech, Nos. 11, 12, 13, 14, and 15, assisted by chief of breech and Nos. 1 and 2, man rammer as near outer end as possible, Nos. 1, 11, 13, and 15, on right, and Nos. 2, 12, 14, and chief of breech on left, in order from head of rammer to rear. At the command RAM, given by the chief of breech, the rammer detail pushes the projectile off the truck and into the breech, gaining increased momentum until the projectile comes up hard in its seat. The ramming detail moves back far enough so that the powder-serving detail can place powder on the shot truck (or on a separate powder tray) in position for ramming. No. 1 places head of rammer against base of powder charge, and at the command RAM, given by the chief of breech, ramming detail pushes powder off tray (or	When dummy ammunition is used, No. 11 brings up extractor and withdraws dummy powder charge. He hooks extractor in dummy projectile and withdraws it, assisted by Nos. 12, 13, 14, and 15.

				truck) and into the powder chamber to such a distance that the breechblock in closing will give the powder a final push into the chamber. Nos. 11, 12, and 13 carry rammer back into position preparatory to ramming next shot. (See note 3.)	
Nos. 16, 17, 18, and 19 (powder detail).	Nos. 16, 17, 18, and 19 bring out powder trays to be used and take post with one of them on side of emplacement toward magazine, facing shot truck. Nos. 17 and 19 on right, Nos. 16 and 18 on left. Nos. 16 and 17 in rear.	(*a*) Examine and clean powder trays and turn them over to ammunition squad. They take position with first loaded tray about 6 yards to right of breech. (*b*) No duties.	No duties.	When rammer has been withdrawn after seating projectile, they carry powder tray to breech and insert nose in breech recess (or put powder on truck in position for ramming). The rammer detail pushes powder off tray (or truck) into powder chamber. The tray (or truck) is then removed and turned over to ammunition squad for refilling. If sectionalized charges are used, No. 16 is responsible for checking their proper arrangement before powder charge is placed in gun.	When dummy ammunition is used, they bring up an empty powder tray to receive dummy charge and return loaded tray to loading position.
No. 20 (sponge detail).	Procures chamber sponge and vessel containing liquid for sponging, places them 7 yards to left rear of breech, and takes post at sponge, facing toward breech.	(*a*) Brings up chamber sponge when called for by chief of breech and assists in sponging chamber. (*b*) No duties.	No duties.	Dips chamber sponge in liquid for sponging, and allows excess liquid to run off. As soon as breechblock is opened after each shot, assisted by Nos. 1 and 2, sponges chamber.	No duties.

NOTES

1. The drill described in this table is designed principally for a 12-inch gun mounted on carriage M1917, and fitted with an M1895MI breech mechanism. If the gun is mounted on carriage M1892, see paragraph 41, FM 4-60. If the gun is fitted with an M1888 breech mechanism, see paragraph 24, FM 4-60.

2. As soon as data are received after the command TARGET has been given, the gun pointer sets on his sight the deflection, and assisted by Nos. 7 and 8, traverses the piece until it is on the target. When firing by case III, he sets the azimuth index to azimuth sent from plotting room.

3. For alternate method of loading see paragraph 17.

4. For duties of the members of the gun section at the commands RELAY and STAND FAST, see paragraphs 21 and 20, FM 4-60.

Section VIII

12-INCH MORTAR

19. Notes on drill.—*Q.* What is the formation for the gun section of the 12-inch mortar? *A.* See figure 13.

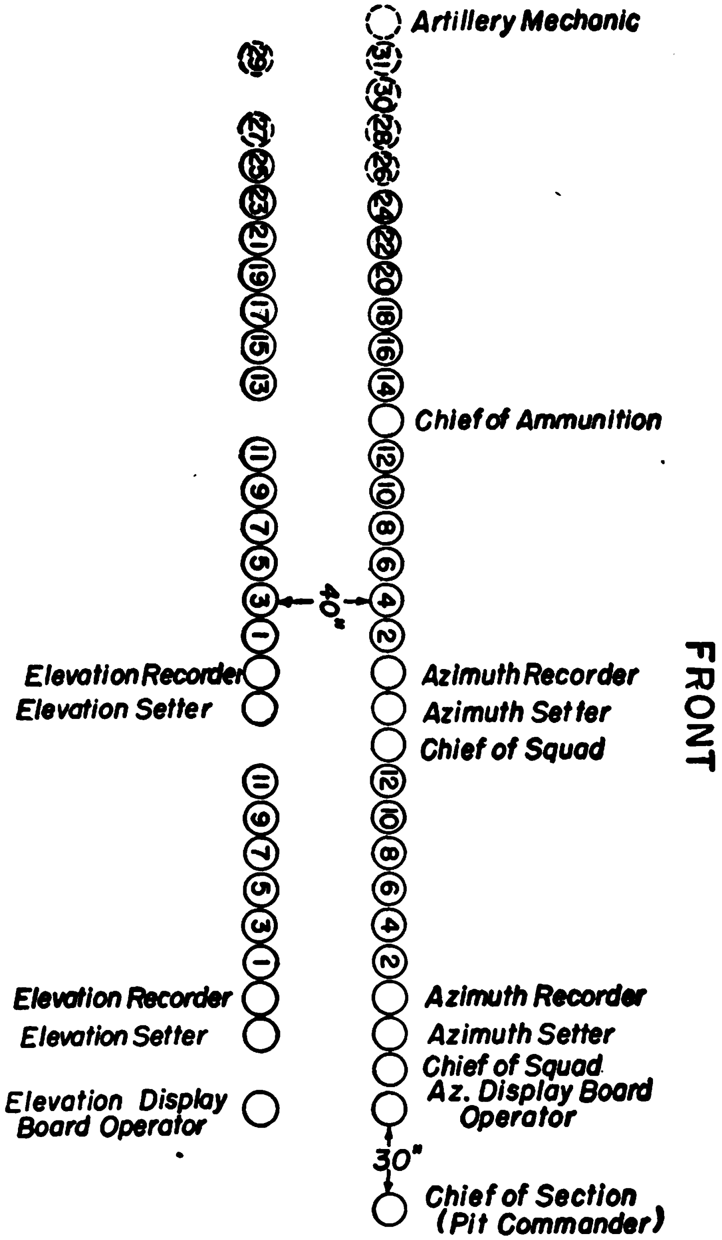


FIGURE 13.—Formation of gun section for 12-inch mortar.

Q. What are the posts of the mortar squad for the 12-inch mortar? *A*. See figure 13.

Q. For what model of mortar and carriage is the drill designed? *A*. The M1912 mortar on the M1896MIII carriage.

Q. What variations in the drill are required for other mortar models? *A*.

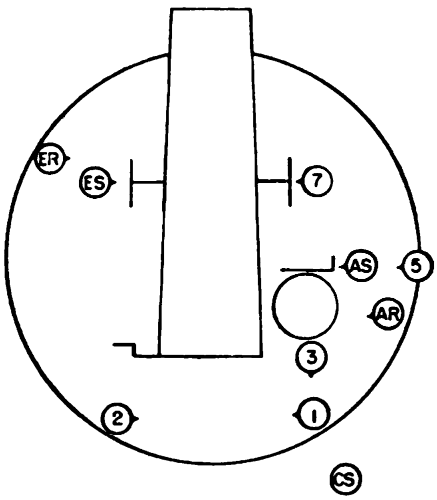


FIGURE 14.—Posts of mortar squad for 12-inch mortar.

(1) *M1890MI mortar.*—The operation of the breech mechanism is different. (See question on operation of breech mechanism.)

(2) *M1908 mortar.*—The mortar is brought to the loading position by means of the quick-loading mechanism without changing the carriage elevation. This operation is similar to the operation of depressing the other types of mortars.

Q. What is the normal procedure at drill? *A*. Loading with dummy ammunition and pointing the piece as for service firing is the normal practice at drill. Fired service primers will be used at drill.

Q. Describe the operation of the breech mechanism. *A*.

(1) *M1890MI mortar.*—(*a*) *To open breech.*—No. 2 pulls out rotating crank lock and turns rotating crank three times in the direction indicated by arrow marked "Open." No. 1 then turns translating crank counterclockwise ending with a quick motion in order to bring the breechblock to its final position in the tray with a jar sufficient to release tray latch. No. 1 then grasps tray handle and assisted by No. 2 swings block until tray back latch engages in its catch.

(*b*) *To close breech.*—No 2 releases tray back latch by raising the handle. He then grasps tray handle and assisted by No. 1 swings tray until it brings up against the face of the breech. No. 2 then

turns translating crank three times in a clockwise direction. No. 1 grasps rotating crank handle and turns crank in a clockwise direction until rotating crank lock engages.

(2) *M1908 and M1912 mortars.*—(*a*) *To open breech.*—No. 2 unlocks breechblock and turns operating crank clockwise until the tray comes to rest against the hinge.

(*b*) *To close breech.*—No. 2 turns operating crank in a counterclockwise direction until breechblock is translated, rotated, and locked in the closed position.

Q. What special information about powder charges for mortars must be known by each member of the gun section? *A*. They must be familiar with appearance of equal-section (aliquot) and base and increment propelling charges for all zones with particular attention to the difference between the igniter end and the front end of the charge. A misfire or hangfire may occur if the propelling charge is loaded with the igniter against the projectile.

Q. How is the gun loaded? *A*. At the command LOAD, given by the gun commander, the following action is taken by each mortar squad: No. 2 unlocks and opens the breechblock, No. 1 assists him by grasping the body of the block and helping to swing the block clear. No. 3 holds the block back during the loading of the projectile and propelling charge. The truck detail runs up the truck; as the truck passes the rammer detail, No. 4 raises the rammer to a horizontal position and places the head against the base of the projectile. The chief of squad and Nos. 1, 2, 4, and 5 take their places on the rammer and follow the truck. In manning the rammer, the men take their places in the following order: The chief of squad at the end, Nos. 1 and 5 on the right, and Nos. 2 and 4 on the left, each man grasping the rammer with both hands and as near the outer end of the rammer stave as possible, thumbs to the rear. As soon as the truck brings up against the face of the breech, the brake is set, the truck detail swings out and around the truck handles, faces the rear, and holds the truck firmly against the breech; crouching down out of the way of the rammer detail. As the truck comes to a stop at the breech, the projectile is rammed home instantly and with all possible force, utilizing its momentum, the speed of ramming being accelerated so that the maximum is reached as the projectile goes into its seat. (If the projectile fails to seat, the chief of squad commands: 1. HOME, 2. RAM, and all men working together heave on the rammer until the projectile is pushed home.) Although speed in loading is desired, it must be subordinated to caution in "running" up the shot truck to the breech recess and in ramming the projectile. Carelessness may

result in injury to the threads of the breech recess, causing the breechblock to stick and slow up the rate of fire. Smooth drill and properly adjusted shot truck buffers will reduce the possibility of burring the threads of the breech recess.

No. 6 places the propelling charge on the truck with the igniter pad to the rear. No. 2 pushes the charge into the chamber by hand until its face barely clears the gas check seat so that it will be pushed into the chamber by the mushroom head. No. 2 assisted by No. 1 closes the breech.

Q. After the piece is loaded, what other operations must be performed before the piece is ready to fire? *A.* As soon as the piece is loaded, the azimuth setter traverses the piece to the azimuth posted on the data board and calls "Set" to the azimuth recorded. He takes cover only after the azimuth recorder has checked and recorded the azimuth set and called "Azimuth set" in a loud voice. When No. 3 commands ELEVATE, the elevation setter assisted by No. 7 unlatches the mortar and elevates to the approximate elevation expected. When the elevation is posted on the data board, the elevation setter sets his quadrant, lays the piece for elevation, and clamps it. He then calls "Set" to the elevation recorder. The elevation setter takes cover only after the elevation recorder has checked and recorded the elevation set and called "Elevation set" in a loud voice. The chief of squad then verifies the laying of the piece, insertion of the firing circuit plug (firing by electricity), and makes a chalk mark on the loading platform opposite the reference mark on the racer. If he notes a sudden increase in azimuth differences, he notifies the battery executive; otherwise he calls "No. —— ready" and takes cover. All members of the squad take cover posts as soon as their duties are completed and in such manner as not to interfere with others whose duties are not completed.

Q. What are the cover posts of the mortar squads? *A.* See figure 15.

	FRONT	
Elevation setter		7
Elevation recorder		Azimuth setter
2		1
12	SHOT	3
8 (or 10)	TRUCK	11 (or 9)
4		5
6		Azimuth recorder

FIGURE 15.—Cover posts for 12-inch mortar squad.

Q. Describe the method of taking cover. *A*.

(1) At the command TAKE COVER, given at any time, the squads take position in rear of the emplacement. Each squad is in double column as shown in figure 15.

(2) Normally the cover post for No. 4 is the same as his regular post and the squad forms on him at the command TAKE COVER. He does not quit the rammer except at the command CEASE FIRING, or when directed to do so, in which case he places the rammer on the rack or prop.

(3) When powder is not served from the rear of the pit, the cover post of No. 6 is near the entrance to the gallery from which the powder is served.

(4) At the commands LOAD, RELAY, and WITHDRAW POWDER CHARGE, cannoneers having duties to perform proceed to their posts as quickly as possible without interfering with each other. Similarly, in taking cover, the details proceed to their posts as rapidly as possible but should avoid interfering with those whose duties at the piece have not been completed.

Q. How is the mortar fired? *A*. At the command or signal FIRE, No. 2 pulls the lanyard (firing by lanyard). The chief of squad listens for the explosion of the primer which may be heard if the propelling charge does not ignite. If a salvo is fired, he watches the muzzle of his mortar and notes whether it fires.

Q. What duties are performed immediately after the piece is fired? *A*. As soon as the piece is discharged, the cannoneers take posts at a run. The elevation setter unclamps the elevating mechanism, and assisted by No. 7 depresses the mortar to the loading position, rapidly but without shock, and sees that the spring latch engages. When necessary, the azimuth setter traverses the mortar to the nearest limit of the loading position. No. 2, assisted by No. 1, opens the breech. No. 1 wipes off the mushroom head. No. 12 assisted by No. 2, sponges the chamber. When necessary, No. 2 cleans the breech recess and the gas check seat. No. 3 hangs the short lanyard in the lanyard safety device, removes the old primer, clears the vent, and cleans the primer seat. All members of the squad stand ready for the next round.

Q. How are the firing data furnished at the mortar pits? *A*. Mortar pits are normally equipped with a mechanical system for posting data which is operated from the plotting room. This equipment is seldom used. It is considered better practice to have the data transmitted by telephone and posted on blackboards by display board operators who should be trained to make legible figures. If the mechanical system is used, its operation should be checked frequently.

Q. How are loading position limits marked? *A*. Loading position limits should be clearly marked, both on the racer and on the floor of the pit. These markings are necessary on both sides of any sector of the field of fire in which loading is impossible. The marking should extend far enough back from the mortar to enable the correct positioning of the shot trucks. A method of marking is to have two parallel lines painted, the distance between them being the width of the shot truck. Drill should be conducted at these limiting positions to determine whether or not there is sufficient clearance for proper ramming.

Q. What precautions should be taken against the concussion of firing? *A*. The concussion caused by mortar firing is very strong. Personnel should not stand near walls or over drains when the piece is being fired. When possible, the knees should be flexed and the mouth open. In general, all doors and windows in the emplacement and in buildings in the vicinity should be opened. If the plotting room adjoins the pit, it may be found necessary to close all openings to prevent the loss of range charts and plotting paper. The emplacement book should be consulted for information on damage caused by concussion in previous firings with a view to preventing its recurrence.

Q. How is drill with dummy ammunition conducted? *A*.

(1) (*a*) For the first and succeeding odd-numbered rounds, the operations of loading, pointing, and firing are as given for service ammunition.

(*b*) For the second and succeeding even-numbered rounds, the operations of sponging and loading are omitted and the operation of unloading is substituted therefor. As soon as the projectile is removed, the breech is closed and the operation of pointing and firing proceeds as for service ammunition.

(2) Unusual events, such as misfires, which may occur during firing, should be simulated during the drill. They should be called by the executive or pit commander without prior information to the mortar squad and in such a manner as to inject realism into the drill.

20. Drill table.—*Q*. What are the duties of the members of the gun section for the 12-inch mortar? *A*. See table VII.

TABLE VII.—*Drill table—Service of the piece, 12-inch mortars (fixed armament)*

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Azimuth setter.	Takes post at traversing handwheel, facing mortar.	(a) Examines azimuth index for adjustment, by observing mark made on racer when piece was last oriented, and examines and tests traversing mechanism. (b) Reports to chief of squad, "Breech in order," or any defects he is unable to remedy without delay.	See note 1.	If not already at his post, takes post at a run and traverses piece rapidly to nearest limit of loading position. As soon as projectile is rammed, traverses piece as rapidly as possible to azimuth setting called off by display board operator and posted on display board. When piece has been pointed accurately in azimuth, calls "Set" to azimuth recorder; takes cover after azimuth recorder has checked and marked azimuth setting and has either signaled or called "Azimuth set" in a loud voice.	Continues to point piece at azimuth posted on display board until the command CEASE TRACKING is given. When dummy ammunition is used, traverses piece to nearest limit of loading position.
Elevation setter.	Takes post at quadrant and elevating handwheel, facing piece.	(a) Examines quadrant and tests elevating mechanism, clamp, and loading position latch. (b) Reports to chief of squad, "Elevation in order," or any defects he is unable to remedy without delay.	See note 1.	If not already at his post, takes post at a run, unclamps elevating mechanism, depresses piece to loading position as rapidly as possible but without shock, and sees that spring latch is engaged; sets quadrant for elevation as soon as elevation is called off by display board operator and is posted on display board. Assisted by No. 7, lays piece accurately in elevation, clamps it, calls "Set," to elevation recorder; takes cover after elevation recorder has checked elevation setting and signaled or called "Elevation set" in a loud voice.	Continues to set quadrant at elevation posted on display board until the command CEASE TRACKING is given. When dummy ammunition is used, returns to the piece at a run, and unclamps elevation mechanism, depresses piece to loading position as rapidly as possible but without shock, and sees that spring latch is engaged.
No. 1 (chief of breech).	Gets cotton waste and a can containing lubricating oil; places them convenient to breech; takes post 1 yard to rear and right of breech, facing it.	(a) Assisted by No. 2, removes breech cover and places it at designated place. Then examines breech mechanism, breechblock, breech recess, chamber, and bore, and gives necessary instructions	No. duties.	Takes post at a run, assists No. 2 in opening breech, assists in ramming, and assists No. 2 in closing breech; takes cover as soon as breech is closed. After each shot, wipes off mushroom head and cleans and oils breech, if necessary.	When dummy ammunition is used, assists No. 2 in opening breech; assists Nos. 2, 4, and 5 in withdrawing projectile.

		for cleaning and putting them into condition for service. (*b*) Reports to chief of squad, "Breech in order," or any defects he is unable to remedy without delay.			
No. 2 (breech detail).	Gets cotton waste and long lanyard (if a lanyard is used), which he coils with hook on top and places convenient to breech; takes post 1 yard to rear and left of breech, facing it.	(*a*) Assists No. 1 in removing breech cover; examines breech recess, gas check seat, obturator head and pad, and cleans and oils them if necessary; examines long lanyard (if one is used) and assists in sponging. (*b*) No duties.	No. duties.	Takes post at a run; assisted by No. 1, opens breech; examines breech recess; wipes any powder residue from breech recess and gas check seat; assists in ramming; pushes powder charge into chamber by hand until its base barely clears gas check seat, so that it will be pushed into chamber by mushroom head as breech is closed. Assisted by No. 1, closes breech. When mortar is to be fired by lanyard, attaches long lanyard to short one, straightens it out after the detail has taken cover, and pulls it at the command FIRE. After each shot, assists No. 12 in sponging chamber.	When dummy ammunition is used, assisted by No. 1, opens breech; withdraws dummy charge and hands it to No. 6; engages extractor in dummy projectiles; assists Nos. 1, 4, and 5 in withdrawing projectile.
No. 3 (breech detail).	Gets primers, primer pouch, punch, drill, reamer, and firing mechanism, and takes post to right of breech, facing No. 1.	(*a*) Examines firing mechanism and places it on obturator spindle; cleans vent and primer seat, and examines short lanyard. (*b*) No duties.	No duties.	Takes post at a run. Holds block back during loading of projectile and powder charge. After breechblock is closed and locked, inserts a primer in vent, lowers leaf of firing mechanism *completely down*, and commands or signals: ELEVATE. When piece is elevated to 43°, inserts firing circuit plug (firing by electricity), or hooks short lanyard and unhooks S-hook from safety lanyard device (firing by lanyard), and takes cover. After each shot, unhooks short lanyard and hangs lanyard in lanyard safety device. As soon as breech is open, removes fired primer, clears vent, and cleans primer seat.	When dummy ammunition is used, removes primer as soon as breech is opened.

TABLE VII.—*Drill table—Service of the piece, 12-inch mortars (fixed armament)*—Continued

Details	DETAILS, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
No. 4 (rammer detail).	Gets rammer and extractor, places latter on rack or prop at convenient point, and takes post well in rear of mortar, rammer vertical, with its head on floor of emplacement.	(*a*) Places rammer on prop and assists in sponging when necessary. (*b*) No duties.	No duties.	As truck passes rammer detail, raises rammer to a horizontal position and places rammer head against projectile. Runs forward with truck. Assisted by chief of squad and Nos. 1, 2, and 5, rams projectile home with all possible force as soon as truck comes to rest with its buffer against face of breech. All then quit rammer except chief of squad and No. 4. The chief of squad pulls rammer smartly to the rear. No. 4 grasps it at the balance, carries it above his head, and takes post, bringing rammer to a vertical position.	When dummy ammunition is used, carries rammer to prop and assists Nos. 1, 2, and 5 in withdrawing projectile. He then takes rammer to his post.
No. 5 (rammer detail).	Gets a wrench for filling plugs and places it convenient to piece. Then takes post 1 yard in rear of azimuth setter, facing piece.	(*a*) Assists No. 6 in examing and filling recoil cylinder. (*b*) No duties.	No duties.	Assists chief of squad and Nos. 1, 2, and 4 in ramming.	When dummy ammunition is used, brings up extractor and, assisted by Nos. 1, 2, and 4, withdraws projectile. Then returns extractor to prop.
No. 6 (powder serving detail).	Gets a wrench for filling plugs, a measure containing recoil oil, and a funnel, and places them convenient to piece and takes post near entrance to powder magazine.	(*a*) Assisted by No. 5, unscrews filling plugs of *both* recoil cylinders and, if oil is needed, fills them. Then notifies chief of squad that recoil cylinders are ready for inspection. After inspection, screws filling plugs well home and replaces his implements. (*b*) No duties.	No duties.	Receives powder charge from a member of ammunition squad and follows truck to breech; as soon as rammer has been withdrawn from breech recess, places powder charge on truck directly in rear of breech recess, with igniter pad to the rear, and takes his post.	When dummy ammunition is used, receives the powder charge from No. 2 and returns it to ammunition squad

No. 7 (elevating detail).	Takes post at right hand elevating handwheel, facing it.	(*a*) Removes muzzle cover and places it at designated place; assists elevation setter in testing elevating mechanism; and cleans and oils gears, if necessary. (*b*) No duties.	No duties.	Takes post at a run; at the command ELEVATE, assists elevation setter in elevating mortar rapidly to approximate elevation and takes cover.	When dummy ammunition is used, returns to piece and assists in depressing it to loading position.
Nos. 8, 9, 10, 11 (truck detail).	Nos. 8 and 9 bring out a loaded truck and run it to a point about 10 feet in rear of breech, No. 8 on the left and No. 9 on the right. Nos. 10 and 11 run an empty truck alongside delivery tables in shot gallery. No. 10 on the left and No. 11 on the right. No. 11 then assists No. 12 in bringing out sponge tub.	(*a*) Nos. 8, 9, 10, and 11 examine trucks and clean and oil them if necessary. (*b*) No duties.	No duties.	Nos. 8, and 9 (or Nos. 10 and 11) run a truck from position of cover to loading position (about 10 feet in rear of breech), and Nos. 10 and 11 (or Nos. 8 and 9) run a loaded truck from the gallery to position of cover just vacated by Nos. 8 and 9 (or Nos. 10 and 11). At the proper time, Nos. 8 and 9 (or Nos. 10 and 11) push truck forward rapidly and bring it up solidly against face of breech, holding it there by setting brake and by pressure on truck handles. As soon as projectile has been rammed home and powder charge inserted, they withdraw truck promptly and run it backward into shot gallery and alongside delivery table. They then roll a new projectile onto the truck. At the next shot, they run loaded truck to position of cover just vacated by Nos. 10 and 11 (or Nos. 8 and 9), who have pushed their truck forward to loading position.	When dummy ammunition is used, Nos. 8 and 9 (or Nos. 10 and 11) bring out an empty truck from the gallery and, when projectile is drawn back on truck, return it to gallery.

Details	DETAILS, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
No. 12 (sponge detail).	Assisted by No. 11, gets sponge tub and sponge, which he places well in rear of emplacement. Fills tub with sponging fluid and then takes post facing mortar. Holds sponge vertical with its head in vessel. (Whenever necessary to move tub it will be carried, not dragged, No. 12 being assisted by other members of squad.)	(*a*) Brings up sponge when called for by No. 1. (*b*) No duties.	No duties.	Removes head of sponge from vessel and allows excess liquid to run off. After each shot, rushes forward with sponge and as soon as breechblock is opened, sponges chamber, assisted by No. 2.	No duties.

NOTES

1. As soon after the command TARGET is given as data are received, the elevation setter sets his quadrant, the azimuth setter traverses the piece to the proper azimuth (or nearest loading position), and Nos. 8 and 9 shift the truck as required.

2. At the command RELAY, No. 2 slacks the lanyard, if used, and the members of the mortar squad perform such of their duties at the commands TARGET and LOAD as may be necessary to lay the mortar on the new data. If the new data involve a change in zone, the command WITHDRAW POWDER CHARGE is given by the pit commander. The mortar squad proceeds as for the command LOAD, except that No. 3 removes the primer before the breechblock is unlocked, No. 1 withdraws the old powder charge, No. 6 inserts the new charge in the chamber. No. 1 turns over the old charge to No. 6, who takes it back to the magazine.

3. At the command CEASE FIRING the lanyard is detached or the firing circuit opened.

4. At the command TAKE COVER, all members of the squad take cover posts at a run.

5. At the command STAND FAST, all movements of personnel and matériel are halted.

Section IX

16-INCH GUN AND HOWITZER

21. Notes on drill.—*Q*. What is the formation for the gun section of the 16-inch gun and howitzer? *A*. See figure 16.

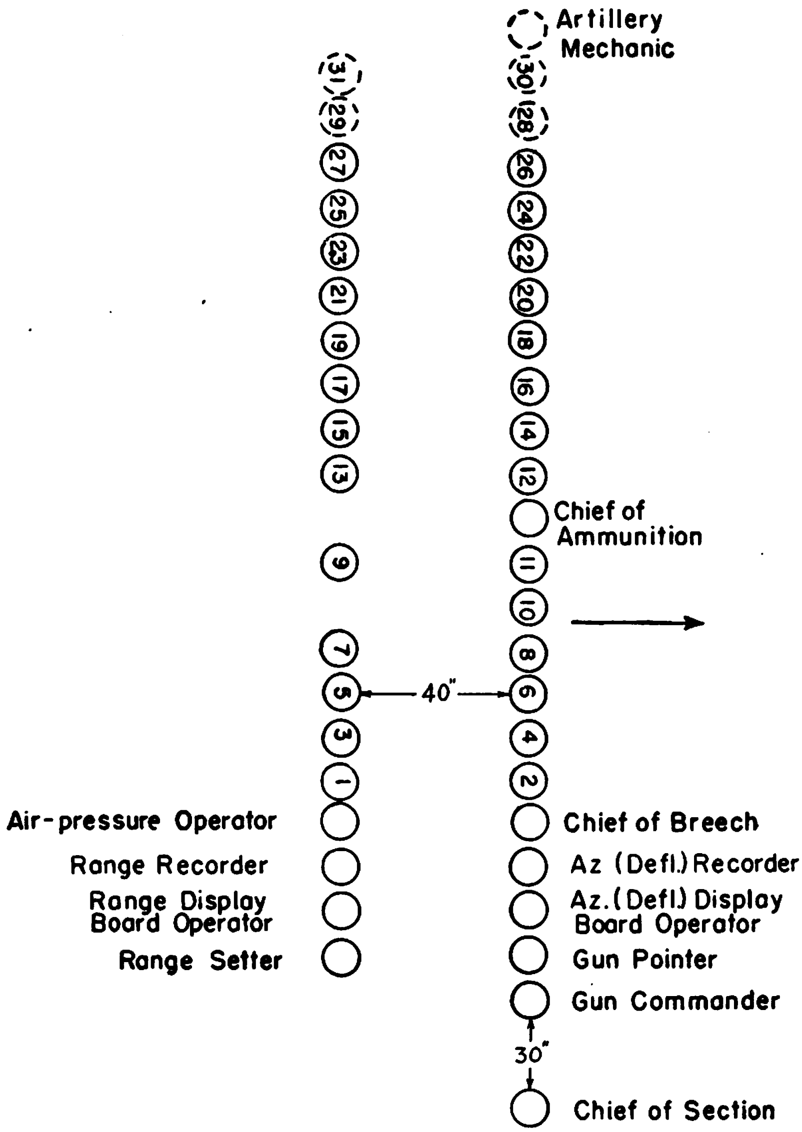


FIGURE 16.—Formation of gun section for 16-inch gun and howitzer.

Q. What are the posts of the gun squad of the 16-inch gun and howitzer? *A*. See figure 17.

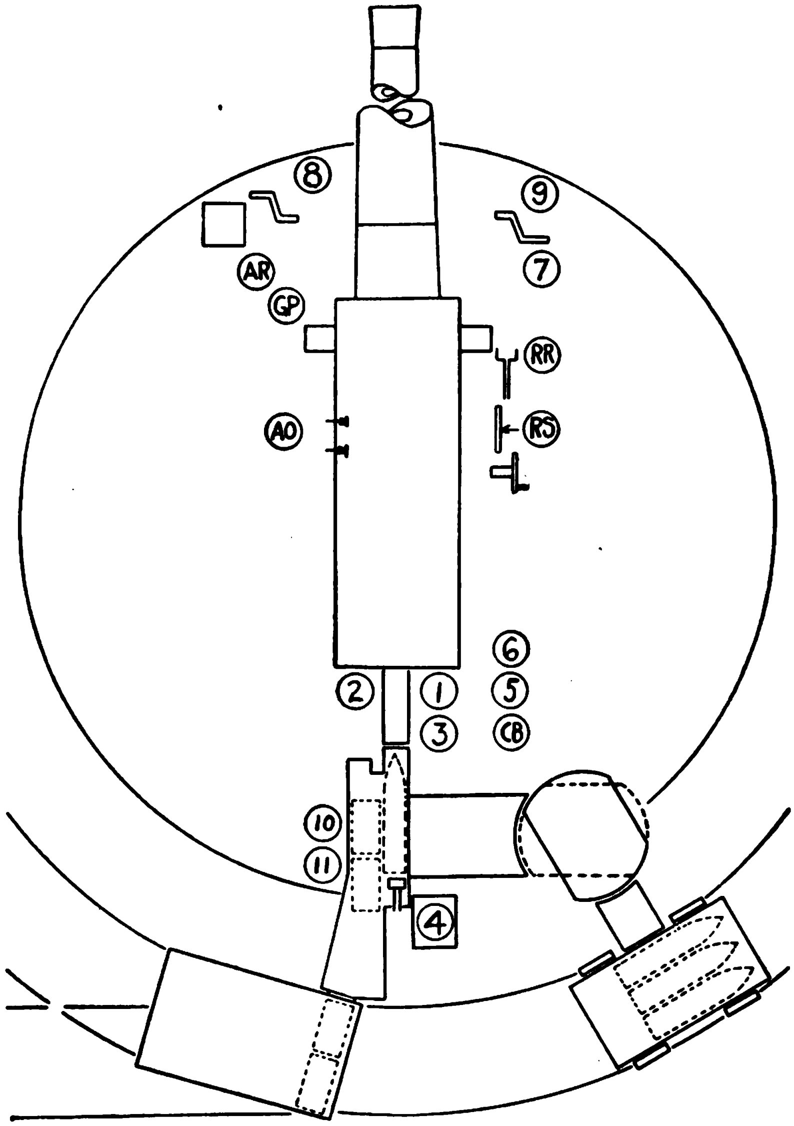


FIGURE 17.—Posts of gun squad for 16-inch gun and howitzer.

Q. How is the firing lock (firing mechanism) assembled to the piece? *A*. No. 3 attaches the assembled firing lock to the obturator spindle by pushing it over the end of the spindle and giving it a quarter turn to the locked position.

Q. How may the piece be fired? *A*. By lanyard or electrically as the firing lock is designed to be used with combination percussion-electric primers.

Q. Describe the method of firing by lanyard. *A*. No. 3 attaches the lanyard to the cocking lever of the firing lock, and walks to the rear through the passage between the powder tray and the left side

of the carriage, uncoiling the lanyard as he goes and takes post on the outer edge of the gun platform in rear of the breech. At the command FIRE, he fires the piece by a quick, strong pull (not a jerk) on the lanyard.

Q. What must be done to prevent the damaging of the firing lock by its closing on a partly extracted primer? *A*. One of the following precautions should be adopted:

(1) After the breechblock is open, and while loading is taking place, No. 3 reaches under the breechblock and makes sure the old primer has been extracted.

(2) Before the breech is opened, No. 3 opens the firing lock by hand and removes the fired primer.

Q. Describe the operation of the breech mechanism. *A*.

(1) *To open.*—No. 2 pushes the salvo latch in the upper cam until it is retained by the salvo latch catch. He raises the operating lever latch disengaging it from the operating lever latch catch, and pulls the operating lever down until the breechblock is disengaged from the threads in the breech recess. Nos. 1 and 2 grasp the breechblock handle and pull the breechblock downward to the full open position where it is brought to rest on the carrier buffers. On the Mk. II model 1 Navy gun, the breechblock is held down by the holding down latch.

(2) *To close by hand.*—Nos. 1 and 2 grasp the breechblock handle and raise the breechblock into the breech recess. No. 2 pushes the operating lever upward until the operating lever catch locks the lever in position. On the Mk. II model 1 Navy gun, No. 1 releases the holding down latch before raising the breechblock.

(3) *To close by air pressure.*—No. 1 or 2, depending on the position of the closing valve, pulls outward on the closing valve handle. The air pressure acting on the pistons of the closing mechanism forces the spring rods to the rear, raising the breechblock into the breech recess. The rotating cam rollers attached to the breechblock sharply strike the paths in the upper and lower rotating cams located on the breech face, giving the breechblock its initial rotation and guiding it to the point of engaging the threads in the breech recess. The momentum of the breechblock acting through a rotating link whips the operating lever upward, rotating and completely closing the breechblock. *No. 2 keeps clear of the operating lever* as it is driven upward with terrific force into its closed position. The shock of the blow is absorbed by the operating lever plunger housed in the upper cam. No. 2 pushes the operating lever home if the force of closing has not caused the operating lever catch to lock the lever in the closed

position. On the Mk. II model 1 Navy gun, No. 1 releases the holding down latch before the closing valve is opened.

Q. How is the gun loaded? *A*.

(1) At the command TARGET, No. 5 moves the rammer control handle to the "on" position and stands ready to assist No. 4. At the command LOAD, No. 4 operates the feed lever of the projectile parking table, placing one projectile on the rammer tray. As soon as the spanner tray is in position and all is clear, he throws the rammer speed lever over toward "Ram," and as the projectible gains velocity, increases the speed so that the maximum will be attained at the moment of seating the projectile. He will be careful that the projectile is not rammed so hard that the ramming chain "buckles" or "jumps." He then throws the speed lever over the "Withdraw" and as rapidly as practicable withdraws the rammer. As soon as the first two sections of the powder charge are in position on the rammer tray, he operates the rammer and pushes these sections forward sufficiently to clear space for the next two sections. He then withdraws the rammer. When the last two powder sections are on the rammer tray, he rams all four sections forward but in such manner that a final forward movement will be given by the mushroom head when the breechblock is closed. This will require training and the use of appropriate marks on the rammer links. At all times he exercises caution in ramming the powder sections to prevent jamming or bursting the sections. When using the howitzer charge or fractional charges, the ramming of the powder sections is modified as circumstances indicate.

(2) In withdrawing the dummy projectile, the projectile will be slowed up with the hand extractor and brought to rest without striking the rammer chain head. A practice of giving the projectile as great a rearward velocity as possible and permitting it to coast down the incline without check until it is stopped violently by the head of the rammer chain will result in seriously damaging the rammer chain hydraulic head and the "B" end of the rammer speed gear.

(3) When the rammer chain is run forward by power without a projectile or powder charge being rammed, No. 4 exercises care to reverse the lever and stop the chain several feet before it has reached its limit of travel. Failure to do this will cause the stop lugs on the last link of the rammer chain to jam violently into the sprocket teeth and injure the gearing. The rammer head must not be allowed to reach the rifled section of the bore, otherwise the rifling will be damaged.

(4) In hand ramming, No. 4 supervises the work of the men on the rammer hand cranks. No. 5 disengages the rammer clutch

from power operation. Nos. 5, 10, and 11, and the nearest man from the powder car, man the left rammer hand crank. One man from the powder car and two men from the projectile car man the right rammer hand crank.

Q. How is the piece placed at the correct loading angle? *A*. The elevation setter brings the piece down until the brass plate on the face of the range disk comes under the pointer.

Q. Why is it important that the loading angle be correct? *A*. At a less elevation too much effort is required to open the breech. At a greater elevation the front end of the spanning tray may not be supported properly in the breech recess and the weight of the projectile may break it. If the breechblock, when open, should rise slightly above its lowest position due to the action of the balance springs, the front end of the spanning tray should be pressed down upon the breechblock until the spanning tray is properly supported by the breech recess.

Q. What other care must be taken in handling the spanning tray? *A*. When returning it from the loading position it must be brought against the stop gently. Striking the stop hard may break it or damage the rammer mechanism housing.

Q. What is the purpose of the recoil parts lock? *A*. The recoil parts lock has been provided to prevent the gun from sliding to the rear when in an elevated position, in case there should be insufficient air pressure in the recuperator cylinders. Before firing or exercising the gun, the air-pressure operator by direction of the gun commander removes the recoil parts lock nut from its bolt, and replaces it immediately upon completion of the firing or exercising. Under no circumstances will the gun be elevated until it is ascertained either that the recoil parts lock is locked, or that there is sufficient air pressure in the recuperator cylinders.

Q. What is the method of starting motors? *A*. To start a motor, *gradually* move the controller handle of the controller drum pertaining to that motor from the "off" position around to the full running position, pausing long enough on each point to allow the motor to pick up speed. Upon an overload or no-voltage condition, the magnetic switches will open and it will be necessary to return the controller handle to the starting position before the motor can be restarted. The motor may be operated at reduced speed by permitting the controller handle to remain in one of the intermediate positions. To shut down the motor, return the controller handle to the "off" position.

22. Drill table.—*Q*. What are the duties of the members of the gun section for the 16-inch gun and howitzer? *A*. See table VIII.

TABLE VIII.—*Drill table—Service of the piece, 16-inch gun and howitzer*

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Gun pointer	When firing by case II, procures the sight and places it in its seat; takes post at the sight, facing the muzzle. When firing by case III, takes post facing the azimuth index on the left of the carriage.	(a) Examines and adjusts the sight (if used) and azimuth index; assisted by No. 8 examines, cleans, and oils the traversing mechanism; tests the electrical firing circuit and causes the firing circuit plug of the firing magneto not in use to be disconnected. (b) Reports to the gun commander, "Traversing in order," or any defects he is unable to remedy.	See note 1.	Keeps the piece pointed in direction. In case II firing, repeats to the deflection recorder the data he sets on the sight; fires the piece or commands: FIRE, as soon as the piece is pointed after the gun commander has called or signaled, "Ready." In case III firing, traverses the piece or directs the traversing so that the azimuth index is set to the displayed azimuth and calls, "Azimuth set"; when firing electrically, the gun pointer fires the howitzer, but the azimuth recorder fires the gun.	Keeps the piece pointed in direction until the command CEASE TRACKING is received.
Range setter	When firing by quadrant, takes post facing the quadrant on the right trunnion. When firing by range scale, procures the range disk, and places it on the elevation drum on the right side of the carriage; takes post facing the scale.	(a) Examines and adjusts the quadrant and range scale. Assisted by No. 6 cleans and oils the elevating mechanism. Before elevating the piece, obtains permission from the gun commander. (b) Reports to the gun commander, "Elevation in order," or defects he is unable to remedy.	See note 2.	When firing by quadrant, sets the quadrant to the displayed elevation; elevates the piece, assisted by No. 6 if necessary, at the command or signal of the chief of breech until the quadrant level bubble is centered; calls, "Elevation set." When firing by range scale, at the command or signal of the chief of breech, elevates the piece, assisted by No. 6, if necessary, to the displayed range; calls, "Elevation set." After the piece has been fired, brings it rapidly to the loading position.	Keeps the piece laid in elevation until the command CEASE TRACKING is received. When dummy ammunition is used, brings the piece to the loading position.
Air-pressure operator.	Procures the controller handle for the air-compressor controller box and places it on its seat. Assisted by Nos. 10 and 11, procures an	(a) Assisted by Nos. 10 and 11, examines and adjusts the air-pressure mechanism and the air and liquid pressures of the recuperator system. Assisted by No.	No duties.	During firing, observes the distance between the piston rod nut and the small gland on the front end of each recuperator plunger; observes the operation of the breech air system.	Corrects the air and liquid pressure of the recuperators and the air pressure of the breech closing mechanism as re-

	air bottle for the recuperator system and places it in position on the left of the carriage. Procures tools to make air connections and adjustments. Takes post on the left side of the carriage facing the pressure gages.	1, adjusts the breech air system. Removes the recoil parts lock when so directed by the gun commander. (*b*) Reports to the gun commander, "Air-pressure in order," or defects he is unable to remedy.			quired. Replaces the recoil parts lock when so directed.
Chief of breech....	Posts his detail after assuring himself that each man has procured the necessary cleaning material and equipment; takes post to the rear and right of the breech where he supervises the functioning of the breech detail.	(*a*) Examines the breech mechanism, firing mechanism, breech recess, chamber and bore, and gives the necessary orders for cleaning and putting them in condition for service. (*b*) Reports to the gun commander, "Breech in order," or defects he is unable to remedy.	No duties.	Supervises the details of loading. As soon as the primer has been inserted and all breech personnel are clear, calls or signals, "Elevate," to the range setter.	When dummy ammunition is used, supervises the withdrawal of the dummy powder charge and projectile.
No. 1 (breech detail).	Procures cotton waste; takes post on the breech operating platform to the right and rear of and facing the breechblock.	(*a*) Assisted by Nos. 2 and 3, removes the breech cover. Examines, cleans, and oils the breech mechanism, and assists in cleaning or sponging the bore and chamber. Assists the air-pressure operator in adjusting the breech air system. (*b*) No duties.	No duties.	Assists No. 2 in opening the breechblock and lowering the spanner tray into the loading position. After the ramming of the projectile and powder is completed, assists No. 2 in withdrawing and raising the spanner tray; trips the closing valve if on the right side of the breech to close the breechblock. If the air pressure fails, assists No. 2 in closing and locking the breechblock by hand. Wipes off the mushroom head after each shot.	When dummy ammunition is used, assists No. 2 in opening the breech, inserting the spanner tray, passing the powder sections to Nos. 10 and 11, and extracting the projectile.

Details	DETAILS, POSTS	(a) EXAMINE GUN (b) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
No. 2 (breech detail).	Procures cotton waste, a wrench for pressure plugs, and a can of lubricating oil; takes post on the breech operating platform to the rear and left of and facing the breechblock.	(a) Assists No. 1 in removing the breech cover. Examines, cleans, and oils the breech recess and assists in cleaning or sponging the chamber and bore. (b) No duties.	No duties.	Assisted by No. 1, opens the breechblock and lowers the spanner tray into the loading position. Assists Nos. 10 and 11 in rolling the powder sections onto the rammer tray after the projectile has been rammed. After the powder has been rammed, unlatches the spanner tray and assisted by No. 1, withdraws it to its raised position; trips the closing valve if on the left side of the breech to close the breechblock. If the air pressure fails, assisted by No. 1, closes and locks the breechblock by hand.	When dummy ammunition is used, assisted by No. 1, opens the breech after the primer has been withdrawn, inserts the spanner tray, receives the hand extractor or power extractor and wrench from Nos. 10 and 11 as required, withdraws the dummy powder sections and projectile.
No. 3 (breech detail).	Procures the firing lock, lanyard, primers, primer pouch, drill, reamer, and cotton waste; takes post in front of the rammer motor, facing the breech.	(a) Examines, cleans, and oils the firing lock and attaches it to the obturator spindle; cleans the vent and primer seat; checks the condition of the lanyard. (b) No duties.	No duties.	After the breechblock has been closed and locked, inserts a primer into the primer seat and completely raises the slide. If firing by lanyard attaches the lanyard and fires the piece at the command FIRE. When the piece has been brought to the loading position, coils and unhooks the lanyard (if used), withdraws the fired primer, clears the vent, and cleans the primer seat.	When dummy ammunition is used, unhooks the lanyard (if used), removes the primer, and stands clear of the breech operations.
No. 4 (rammer detail).	Procures cotton waste and an oil can; takes post on the rammer operating platform, facing the rammer control lever.	(a) Directs the examining, cleaning, and lubricating of the rammer mechanism, projectile parking table, and revolving projectile table. (b) Reports to the gun commander, "Rammer in order," or defects he is unable to remedy.	No duties.	Operates the feed lever of the projectile parking table, placing one projectile on the rammer tray. As soon as the spanner tray is in position and all is clear, rams the projectile and powder charge.	No duties.

No. 5 (rammer detail).	Procures the controller handle for the rammer controller box and places it on its seat; takes post at the handle, facing No. 4.	(*a*) Assists No. 4 in examining, cleaning, and lubricating the rammer mechanism, projectile parking table, and revolving projectile table. (*b*) No duties.	See note 3.	Stands ready to assist No. 4. When projectiles are being delivered to the revolving projectile table, assists in operating table.	No duties.
No. 6 (elevating detail).	Procures the controller handle for the elevating controller box and places it on its seat; takes post thereby.	(*a*) Assists the range setter in examining, cleaning, and oiling the elevating mechanism. (*b*) No duties.	See notes 2 and 3.	If elevating is by power, operates the speed control when the quadrant is used. If elevating is by hand, assists in elevating the piece at the elevating handwheel or crank, under the direction of the range setter.	Assists the range setter.
Nos. 7, 8, and 9 (traversing detail).	Nos. 7 and 9 procure the hand traversing cranks and place them in position; take post at right traversing crank, No. 7 facing to the front and No. 9 facing No. 7. No. 8 procures the traversing controller box handle and places it on its seat; takes post thereby.	(*a*) Nos. 7 and 9 remove the muzzle cover. If the powder chamber and bore need cleaning, No. 7 procures the chamber sponge and No. 9 the bore sponge. Nos. 7 and 9 assist in the cleaning, then replace the sponges. Nos. 7 and 9 assist No. 4 in examining, cleaning and lubricating the revolving projectile table. No. 8 assists the gun pointer in examining, cleaning, and oiling the traversing mechanism. (*b*) No duties.	See notes 1 and 3.	If traversing is by power, No. 8 moves the traversing clutch lever to power control; Nos. 7 and 9 assist in the delivery of projectiles to the revolving projectile table and in the operation of the table. If traversing is by hand, No. 8 moves the clutch lever to hand control; Nos. 7, 8, and 9 take posts at the hand traversing cranks, assisting in the traversing as directed.	No duties.

TABLE VIII.—*Drill table—Service of the piece, 16-inch gun and howitzer*—Continued

Details	DETAIL, POSTS	(*a*) EXAMINE GUN (*b*) REPORT	TARGET	COMMENCE FIRING (LOAD)	CEASE FIRING
Nos. 10 and 11 (powder-serving detail).	Assist the air-pressure operator in procuring a charged air bottle and placing it in position. No. 10 procures the hand extractor, and No. 11 the power extractor and wrench. They take post on the left of the powder tray.	(*a*) Assist the air-pressure operator in examining, cleaning, and adjusting the air-pressure mechanism, and in adjusting the air and liquid pressures of the recuperator system. (*b*) No duties.	No duties.	Assist in the delivery of powder charges from the powder cars to the powder tray; assisted by No. 2, roll the powder sections onto the rammer tray after the projectile has been rammed.	When dummy ammunition is used, pass the hand extractor or power extractor and wrench to No. 2 as required; assist in withdrawing the dummy powder charges and putting them on the powder cars.

NOTES

1. At the command TARGET, the gun pointer in case II firing sets on the sight the deflection posted on the display board; the gun pointer traverses the piece if by power, or the traversing detail, under the direction of the gun pointer, traverses the piece by hand until the line of sight is on the target; the gun pointer calls, "On target"; the gun pointer continues to set the data posted on the display board. and assisted by the traversing detail, if necessary, follows the target. In case III firing, the gun pointer traverses the piece if by power, or the traversing detail, under the direction of the gun pointer, traverses the piece by hand until the azimuth index is set to the azimuth posted on the display board; the gun pointer calls, "Azimuth set"; the gun pointer assisted by the traversing detail, if necessary, continues to traverse the piece according to data posted on the display board.

2. At the command TARGET, the range setter and No. 6 stand ready to elevate the piece according to the displayed data.

3. At the command TARGET; if ramming, elevating, and traversing is by power, Nos. 5, 6, and 8, respectively, start the ramming, elevating, and traversing motors.

4. At the command STAND FAST, all movements of matériel and personnel cease.

5. At the command RELAY, the display board operators post the new data on the displaying boards, the gun pointer and range setter continue to point the piece in direction and elevation according to the new data, and No. 3 slacks the lanyard (if used).

Chapter 3

GUN AND MOUNT

Section I

NOMENCLATURE OF GUN AND CARRIAGE

23. General.—*Q*. To what cannon is your battery assigned? *A*. ———.

Q. On what kind and model of carriage are the cannon mounted? *A*. ———.

24. Guns.—*Q*. Point out, or describe the location of, and explain the purposes of the following parts of the guns assigned to your battery:

Bore.	Firing mechanism.	Muzzle.
Breech.	Forcing cone.	Powder chamber.
Breech mechanism.	Gas check seat.	Trunnion band.
Breech recess.	Grooves.	Trunnions.
Centering slope.	Lands.	Tube.

A. (Practical demonstration.)

Q. Point out, or describe the location of, and explain the purposes of the following parts of the breech mechanism of the guns assigned to your battery:

(1) *All types.*

Breechblock.	Gear segment.	Split rings.
Breech plate.	Guide rails.	Teat wrench holes.
Dummy pressure plugs.	Hinge pin.	Threaded sector.
	Mushroom head.	Tray.
Filling-in disk.	Obturator spindle.	Tray latch and catch.
Gas-check pad.	Slotted sector.	Vent.

(2) *Stockett type.*

Compound gear.
Bell crank handle.
Locking bolt.
Operating crank.
Worm wheel.

(3) *Translating roller type.*

Rotating crank.
Securing latch handle.
Translating crank.
Tray handle.

(4) *Banjo type.*

Block handle.
Rack.
Rotating crank.
Rotating gear.
Rotating pinion.
Tray back-latch and catch.
Tray handle.
Translating crank.
Translating roller.

(5) *Rapid-fire type.*

Block carrier.
Firing lever.
Latch groove.
Latch.
Operating lever.
Operating spool.
Rack.
Rack-lock handle.
Slide.

A. (Practical demonstration.)

Q. Point out, or describe the location of, and explain the purposes of the following parts of the firing mechanism of the guns assigned to your battery:

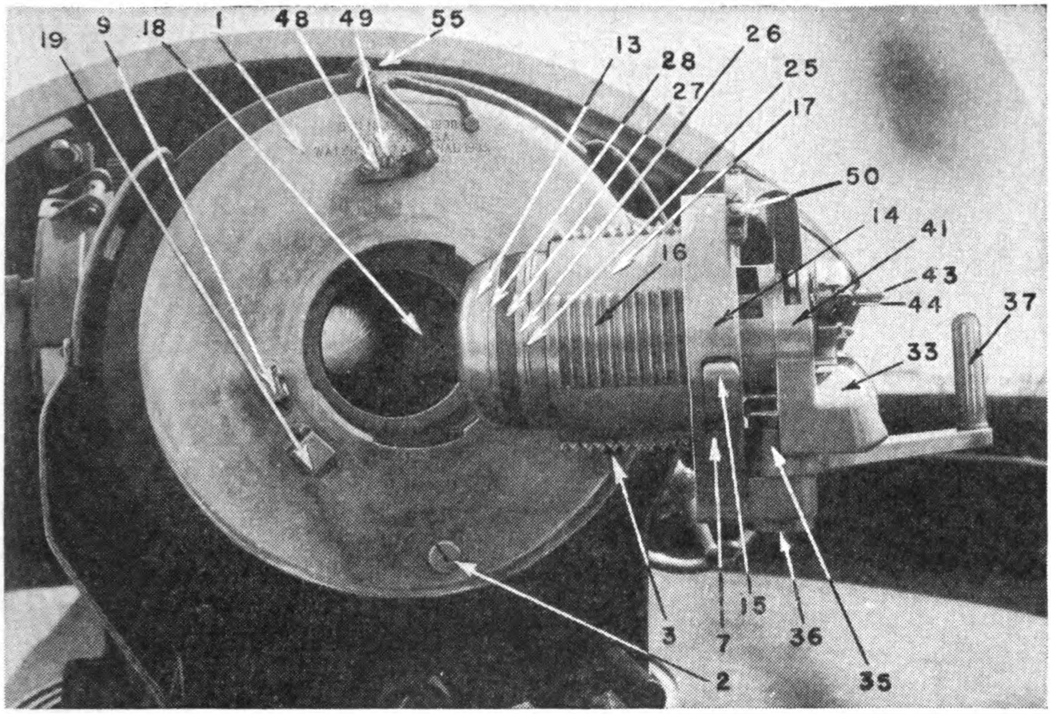
(1) *General.*

Ejector.
Firing leaf.
Guide bar.
Hinged collar.
Safety bar.
Safety-bar slide.
Safety lanyard.

(2) *Electric firing circuits.*

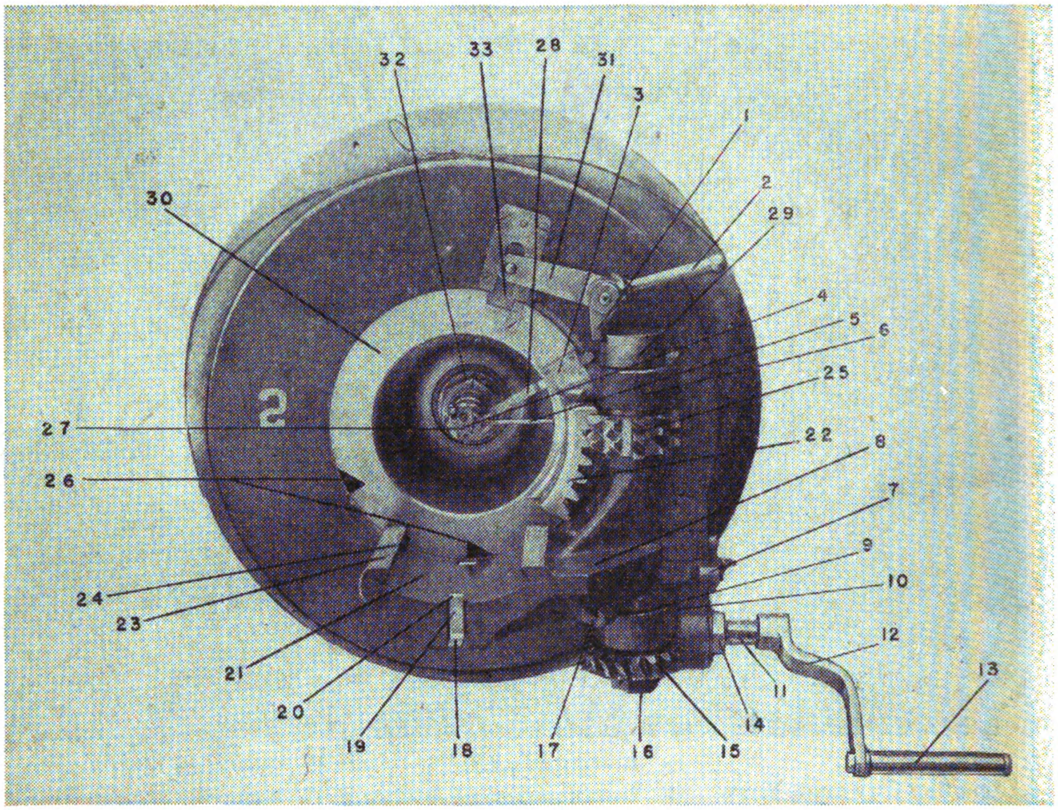
Circuit-breaker contact.
Circuit-breaker housing.
Contact clip.
Firing cable.

A. (Practical demonstration.)



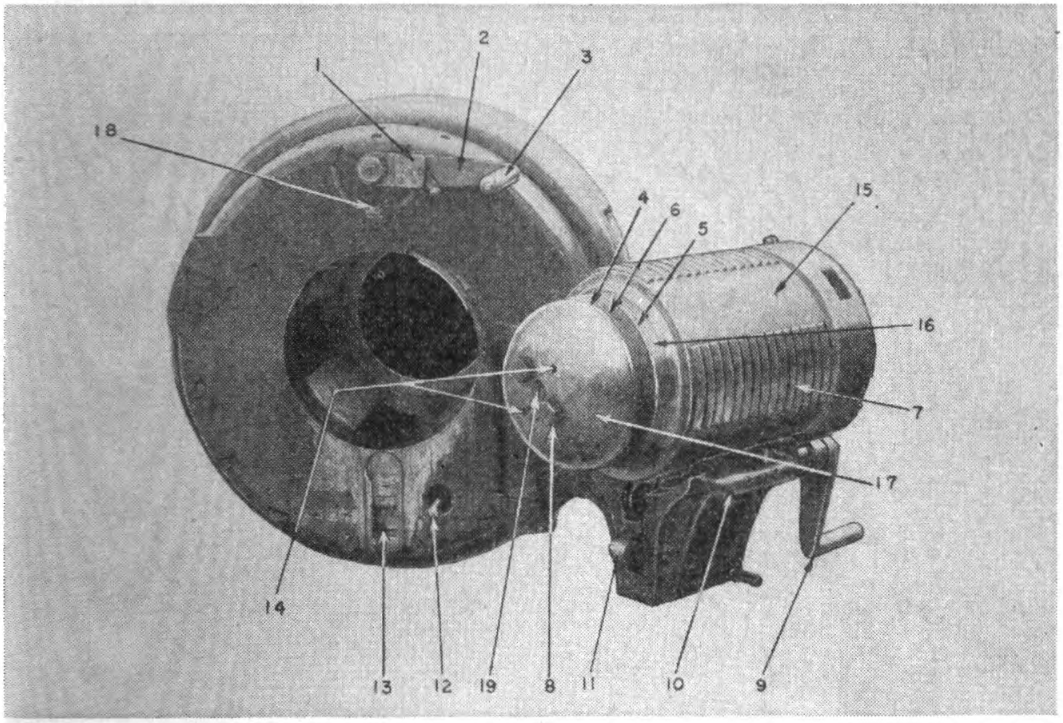
1. Breech face.
2. Loading tray guide screw.
3. Loading tray pivot hole.
7. Latch bolt.
9. Tripping stud.
13. Mushroom head on obturator spindle.
14. Block carrier and plate.
15. Latch lever.
16. Threaded sector.
17. Slotted sector.
18. Breech recess.
19. Latch bolt seat.
25. Filling-in disk.
26. Exterior split ring (rear).
27. Gas check pad.
28. Exterior split ring (front).
33. Gear segment.
35. Pinion.
36. Pinion pivot.
37. Operating lever.
41. Housing.
43. Slide handle.
44. Slide catch.
48. Circuit-breaker contact piece.
49. Contact piece screw.
50. Circuit-breaker housing.
55. Cable clamp.
57. Contact clip.

FIGURE 18.—Stockett breech mechanism for 6-inch gun M1900.



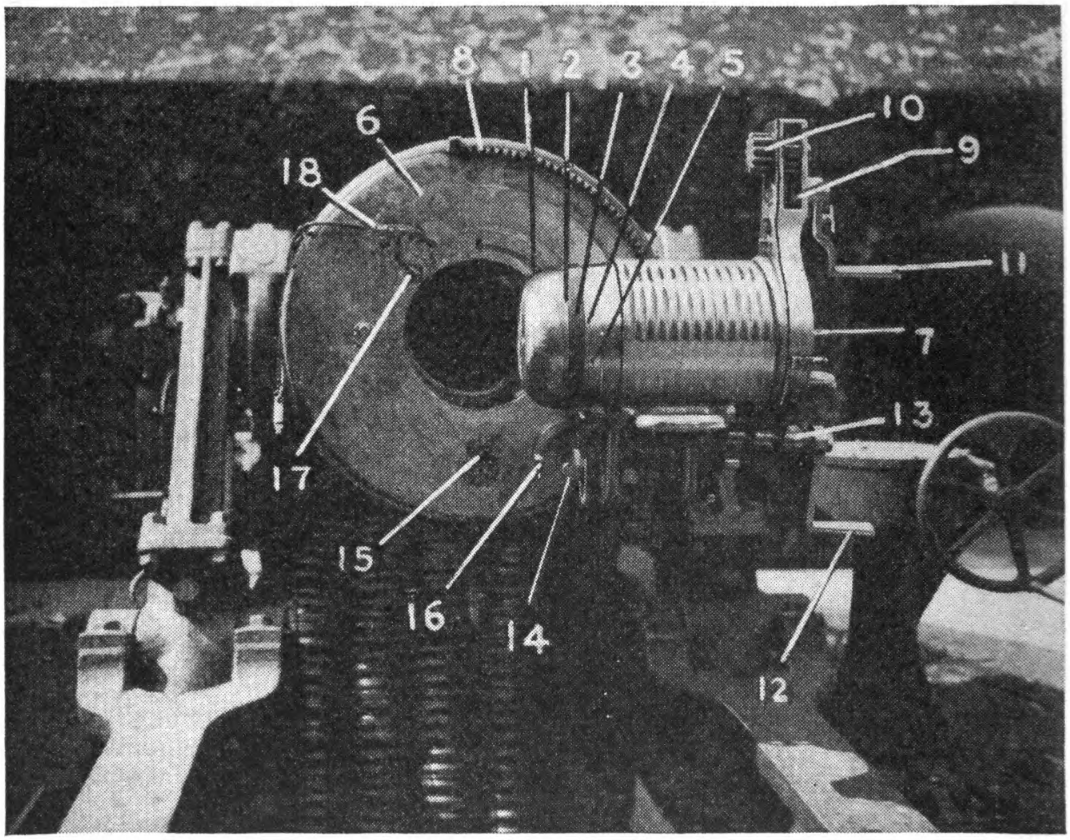
1. Short arm of bell crank lever.
2. Bell crank handle.
3. Safety bar slide housings.
4. Firing box.
5. Firing mechanism guide bar.
6. Hinge.
7. Securing latch catch.
8. Hinge web.
9. Ball bearing washer.
10. Hinge lug.
11. Worm shaft.
12. Operating crank.
13. Operating crank handle.
14. Worm shaft bushing.
15. Worm wheel.
16. Hinge pin nut.
17. Securing latch.
18. Tray latch handle.
19. Tray latch.
20. Tray latch toe.
21. Tray.
22. Rotating lug.
23. Guide rail.
24. Tray latch seat.
25. Compound gear.
26. Guide grooves.
27. Lanyard eye.
28. Safety bar slide.
29. Hinge pin.
30. Breechblock.
31. Long arm of bell crank lever.
32. Obturator nut.
33. Locking bolt.

FIGURE 19.—Stockett breech mechanism for 12-inch gun M1895 and M1900.



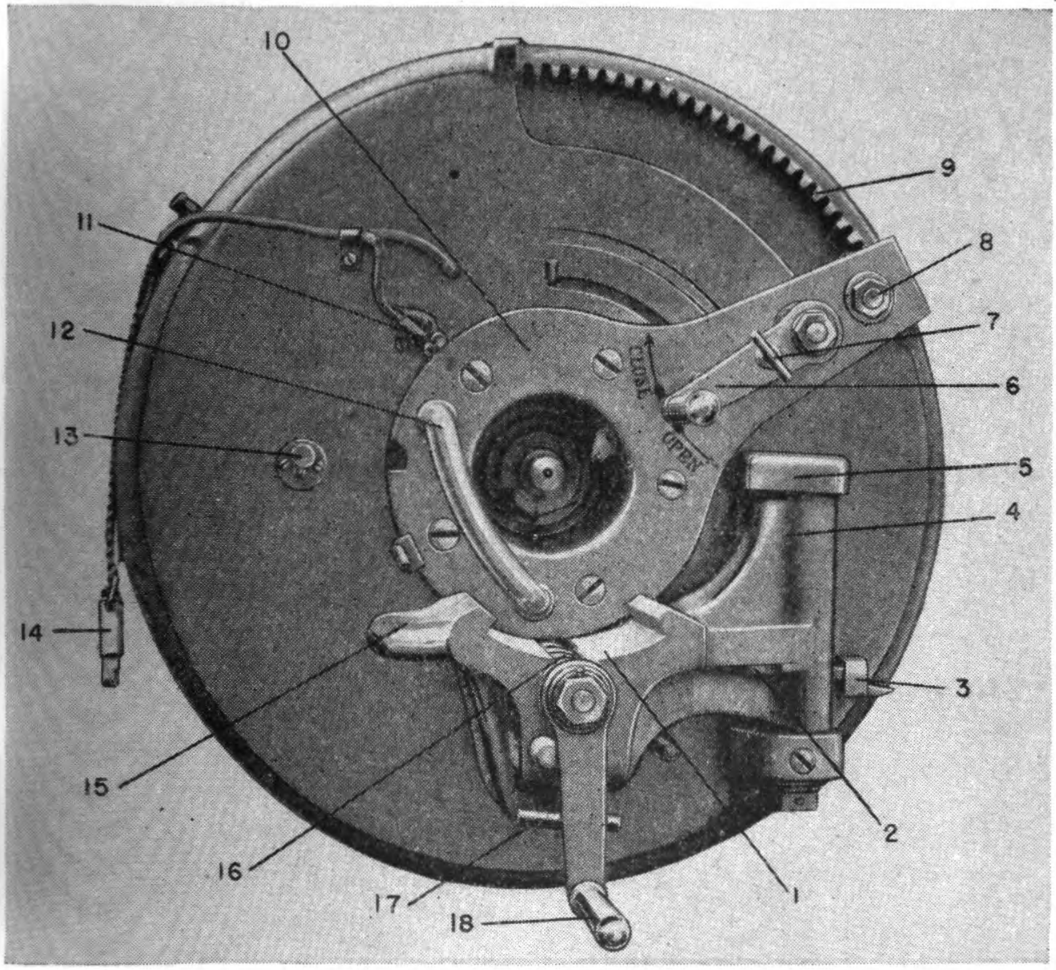
1. Rotating crank box.
2. Rotating crank.
3. Rotating crank handle.
4. Outer split ring (front).
5. Outer split ring (rear).
6. Gas check pad.
7. Threaded sector.
8. Pressure gage seat plugs.
9. Translating crank.
10. Tray handle.
11. Tray latch.
12. Securing latch handle.
13. Tray latch catch.
14. Holes for teat-wrench.
15. Slotted sector.
16. Filling-in disk.
17. Obturator (mushroom) head.
18. Rotating crank lock plate.
19. Vent.

FIGURE 20.—Translating roller breech mechanism, 10-inch gun M1888.



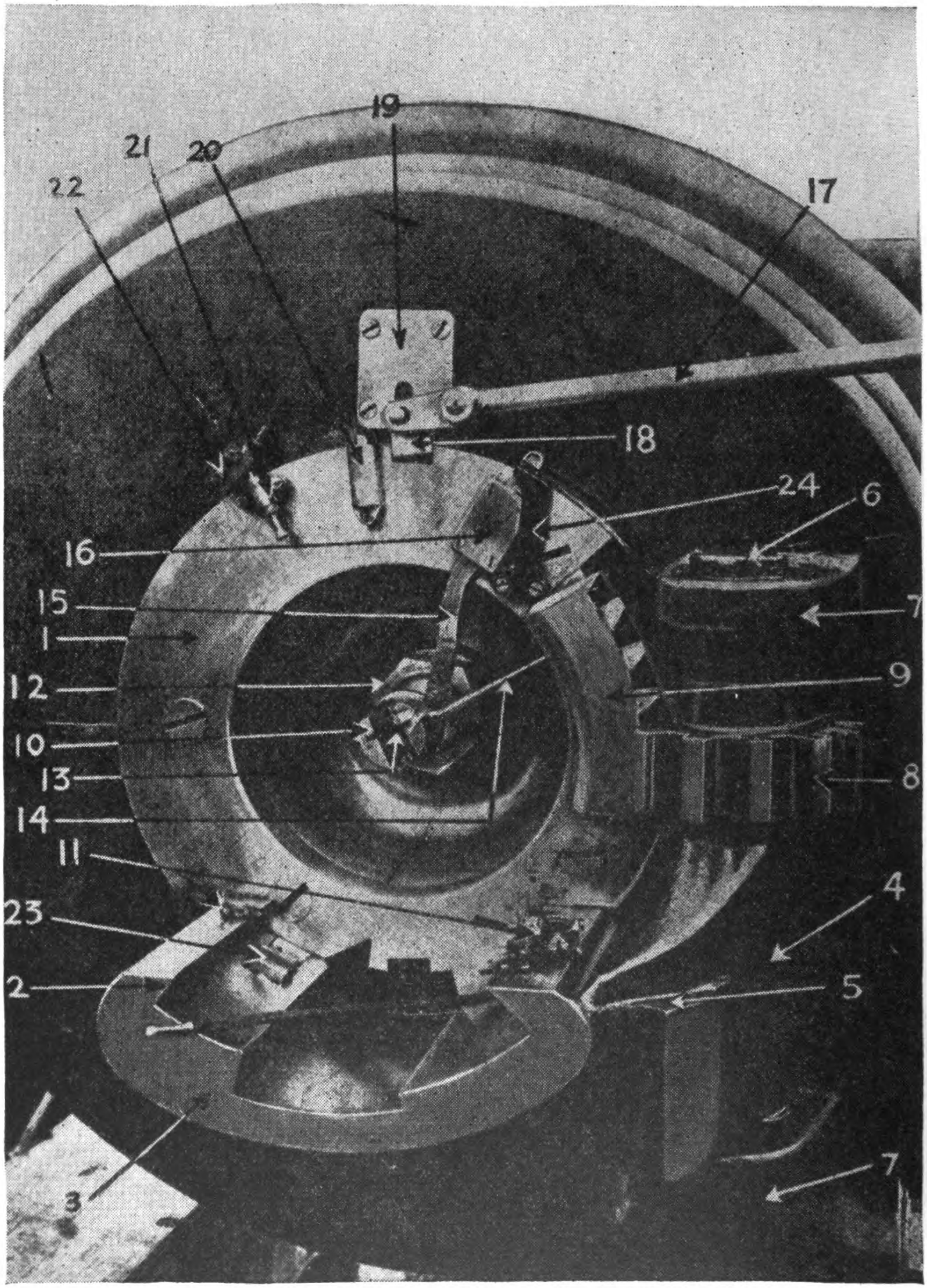
1. Obturator (mushroom) head.
2. Outer split ring (front).
3. Gas check pad.
4. Outer split ring (rear).
5. Filling-in disk.
6. Breech face.
7. Breechblock.
8. Rotating rack.
9. Rotating pinion.
10. Rotating gear.
11. Rotating crank.
12. Translating crank.
13. Translating roller.
14. Tray latch.
15. Tray latch catch.
16. Securing latch handle.
17. Circuit breaker contact piece.
18. Cable clamp.

FIGURE 21.—Breech mechanism (banjo), 12-inch mortar (open).



1. Tray.
2. Tray back latch catch.
3. Tray back securing latch.
4. Hinge.
5. Hinge boss.
6. Rotating crank.
7. Rotating crank catch lock.
8. Rotating pinion shaft.
9. Rotating rack.
10. Face plate (banjo).
11. Circuit breaker (electric firing circuit).
12. Block handle.
13. Safety lanyard device.
14. Electric firing plug.
15. Tray handle.
16. Translating roller.
17. Tray latch handle.
18. Translating crank.

FIGURE 22.—Breech mechanism (banjo), 12-inch mortar (closed).



1. Breechblock.
2. Guide rail.
3. Tray.
4. Tray hinge.
5. Hinge web.
6. Hinge pin.
7. Hinges.
8. Compound gear.
9. Rotating lug.
10. Firing mechanism housing.
11. Firing mechanism parts (not assembled).
12. Locking nut, obturator spindle.
13. Vent.
14. Guide bar of firing mechanism.
15. Safety-bar slide.
16. Safety-bar slide housing.
17. Locking lever.
18. Locking slide.
19. Groove cover.
20. Breech detent.
21. Circuit-breaker housing.
22. Circuit-breaker contact piece.
23. Tray latch.
24. Safety-bar lock.

FIGURE 23.—Breech mechanism, 14-inch gun M1910.

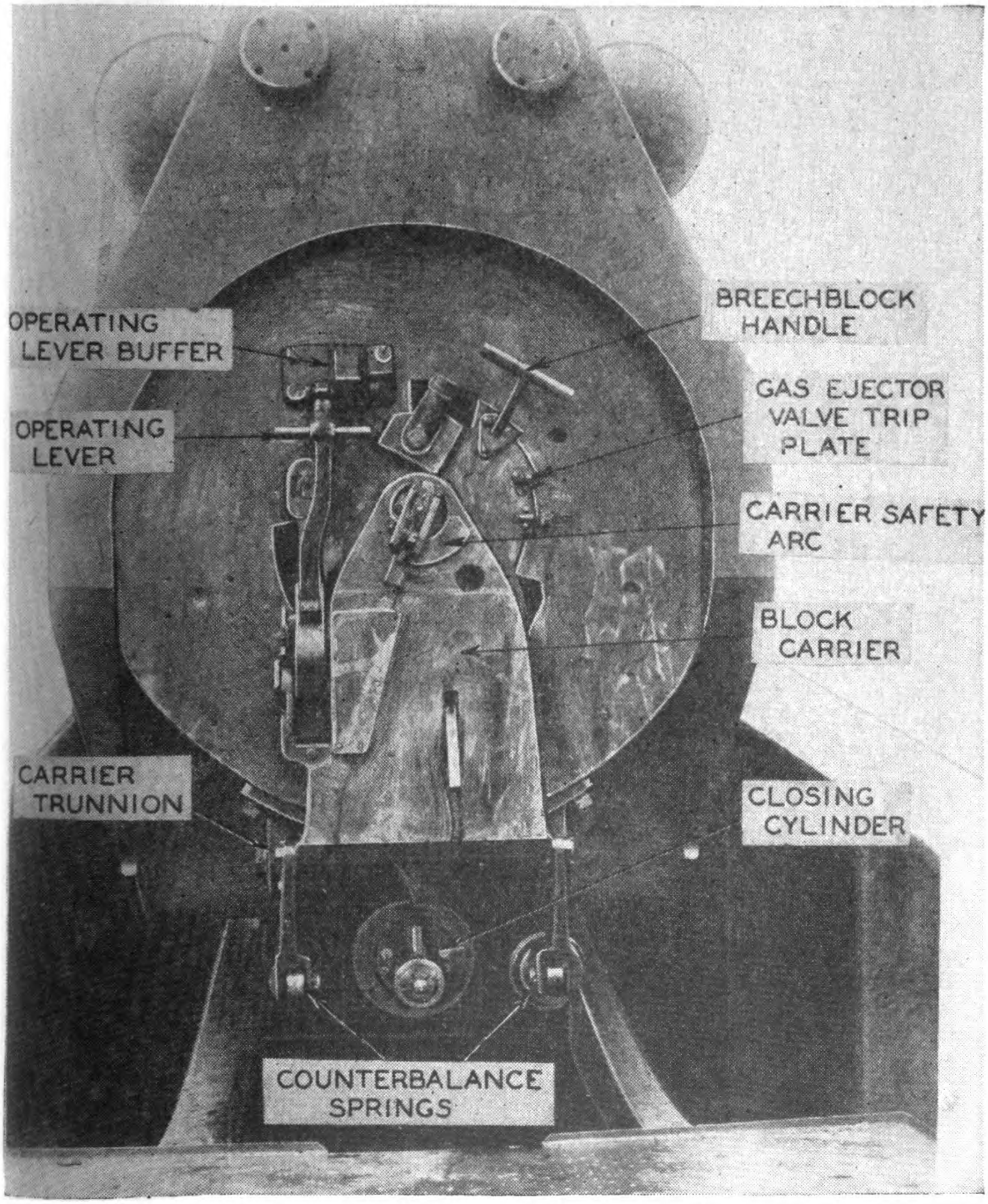


FIGURE 24.—Breech mechanism, 16-inch gun or howitzer (closed).

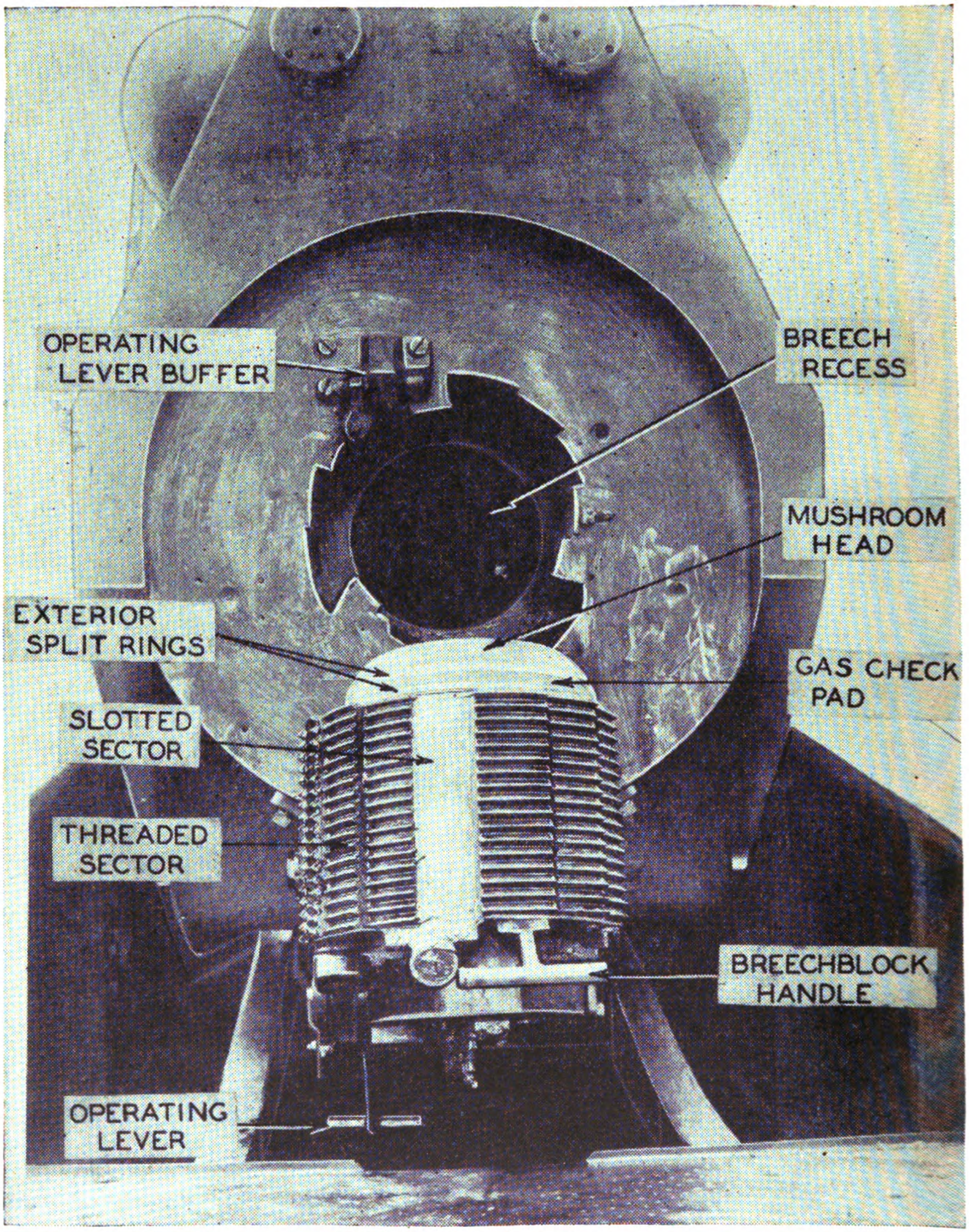
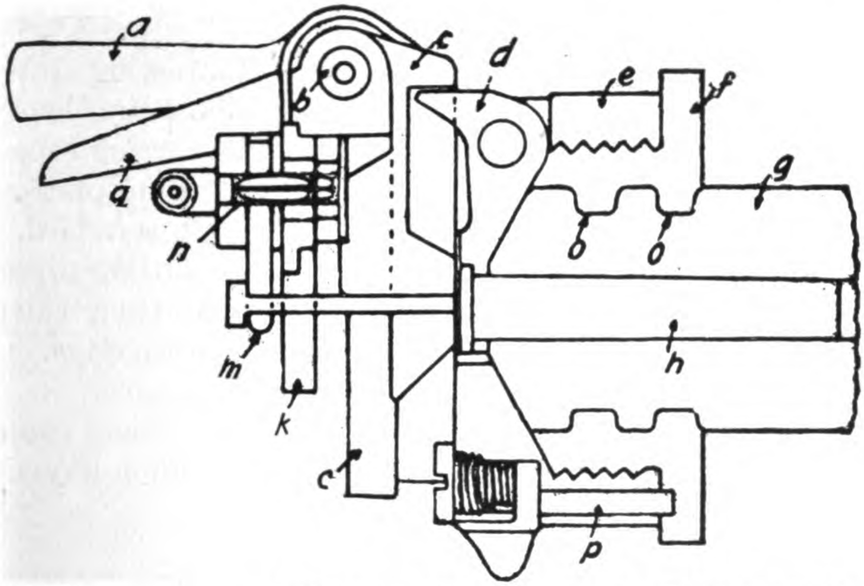


FIGURE 25.—Breech mechanism, 16-inch gun or howitzer (open).



a. Slide handle.
b. Firing leaf pivot.
c. Slide.
d. Ejector.
e. Housing.
f. Hinged collar.
g. Firing mechanism seat.
h. Primer.
k. Firing leaf.
m. Contact clip.
n. Electric terminal.
o. Seat grooves.
p. Spring pin.
q. Catch lever.

FIGURE 26.—Seacoast firing mechanism M1903.

25. Carriages.—*Q*. Point out or describe the location of such of the following parts as apply to the carriages assigned to your battery:

(1) *General.*

Azimuth circle.
Azimuth pointer.
Base ring.
Cap squares.
Chassis.
Counterrecoil system.
Cradle.
Cradle trunnions.
Distance ring.
Dust guard.
Elevating controller.
Elevating handwheel.
Followers.
Grease cups.
Loading platform.
Oil holes.
Pintle.
Piston.
Piston rods.
Racer.
Range pointer.
Range scale.
Recoil band.
Recoil clips.
Recoil cylinders.
Recoil racks.
Recoil rollers.
Roller path, lower.
Roller path, upper.
Side frames.
Stuffing boxes.
Throttling bars.
Traversing crank.
Traversing rack.
Traversing rollers.
Trunnions.
Trunnion band.
Trunnion bed.
Yoke.

(2) *Disappearing gun carriages.*

Combination recoil and buffer valve.
Connecting pipe.
Counterbalance.
Counterrecoil buffers.
Counterweight.
Cross head.
Cross head guides.
Cross head pawls.
Cross head racks.
Cylinder guides.
Elevating arm.
Elevating slide.
Equalizing pipe.
Gun lever.
Gun-lever axle.
Idler.
Maneuver lever.
Recoil buffers.
Retracting clutch handle.
Retracting cranks.
Retracting drums.
Retracting hooks.
Retracting ropes.
Sighting platform.
Sight standard.
Throttling pipes.
Throttling valve.
Top carriage.
Transoms.
Traversing controller.
Tripping levers.

A. (Practical demonstration.)

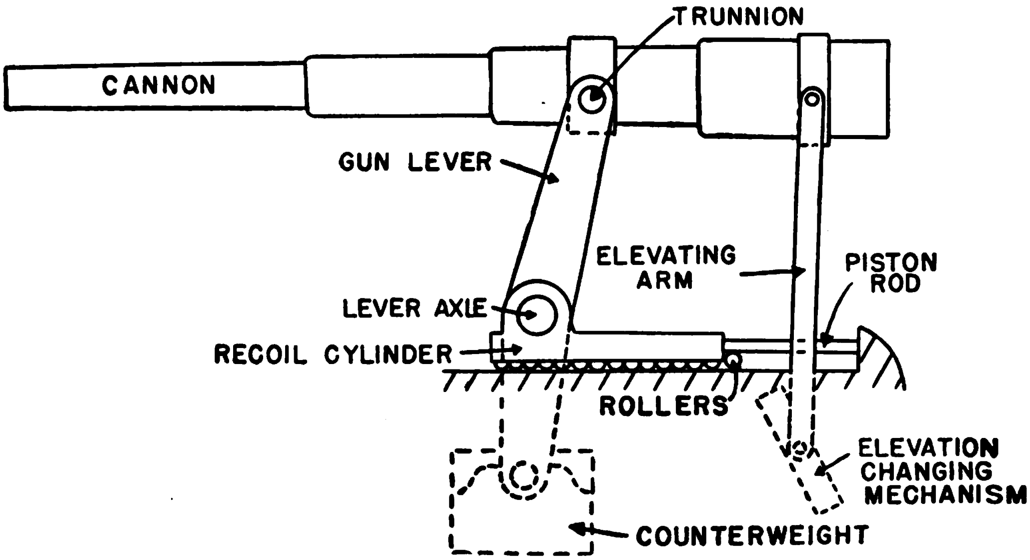


FIGURE 27.—Simplified drawing of disappearing carriage.

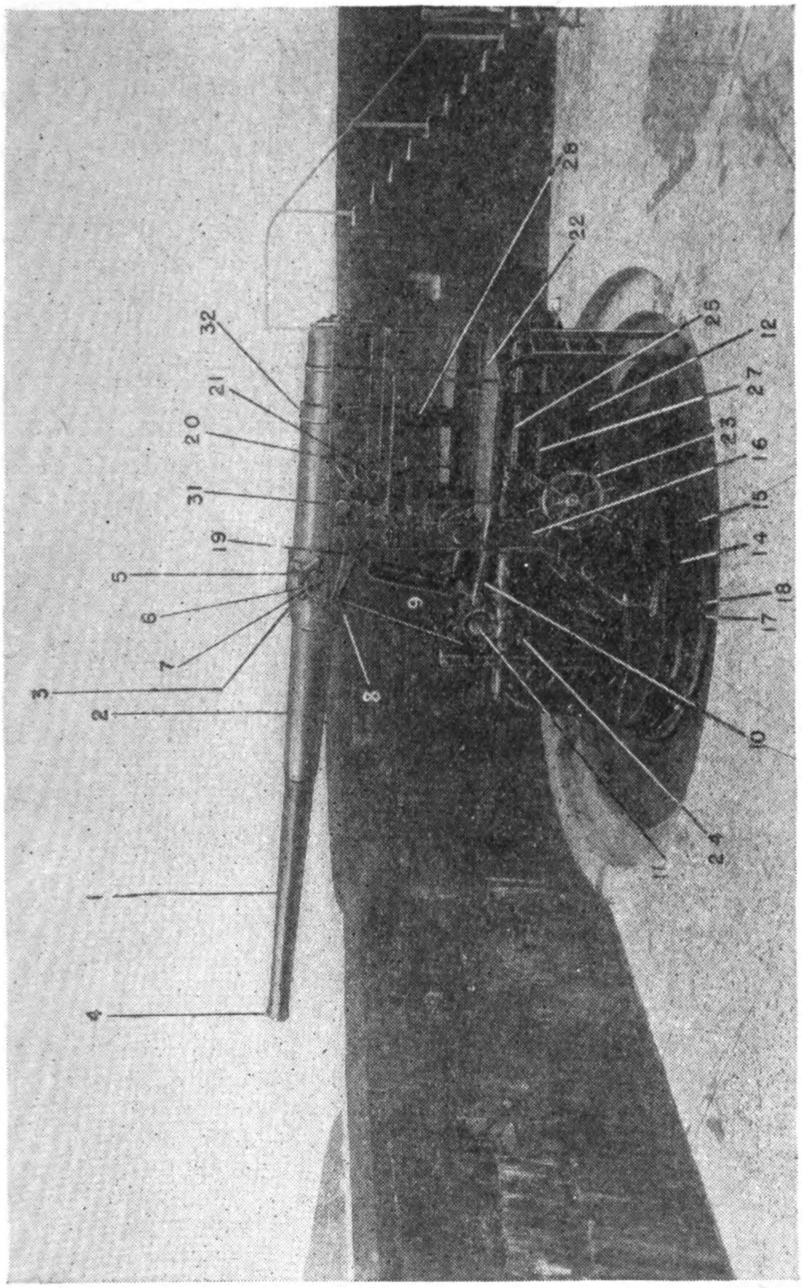
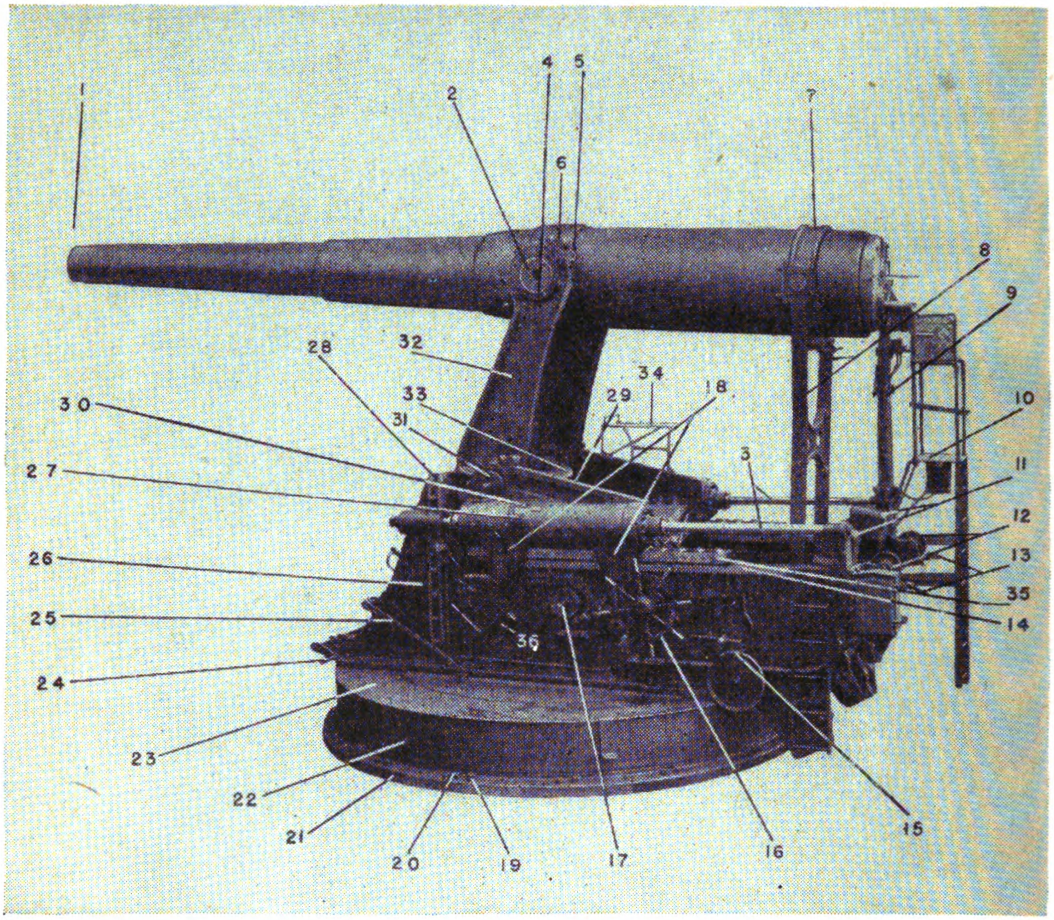


FIGURE 28.—6-inch gun M1905 on disappearing carriage M1905.

1. "C" hoop.
2. "B" hoop.
3. "A" hoop.
4. Muzzle swell.
5. Trunnion hoop.
6. Cap square and retraction hook.
7. Gun trunnion.
8. Grease cap.
9. Gun levers.
10. Top carriage.
11. Gun lever trunnion.
12. Chassis.
14. Dust guard.
15. Base ring.
16. Sight standard.
17. Leveling screw.
18. Foundation bolt.
19. Sight arm.
20. Shoulder rest.
21. Traversing handwheel.
22. Sighting platform.
23. Elevating handwheel.
24. Recoil rollers and roller cage.
25. Piston rod.
27. Recoil roller path.
28. Elevating arms.
31. Sight cradle.
32. Elevating band.



1. Muzzle swell.
2. Gun trunnions.
3. Piston rods.
4. Trunnion beds.
5. Retraction hook.
6. Trunnion hoop.
7. Elevating band.
8. Elevating arms.
9. Sight standard.
10. Gun pointer's platform.
11. Recoil buffer pads.
12. Retraction pulleys.
13. Retraction loops (on end of retraction cables).
14. Recoil roller path.
15. Range scale and pointer.
16. Elevating handwheel.
17. Retraction shaft.
18. Cylinder guides.
19. Foundation bolts.
20. Leveling screw.
21. Base ring.
22. Dust guard.
23. Racer.
24. Traversing crank.
25. Tripping lever.
26. Chassis.
27. Recoil cylinder.
28. Cross head guide.
29. Top carriage.
30. Filling plug.
31. Gun lever trunnion.
32. Gun lever.
33. Transom.
34. Gun pointer's platform (case I).
35. Recoil rollers and roller cage.
36. Retraction crank.

FIGURE 29.—10-inch gun M1888MI on disappearing carriage M1896.

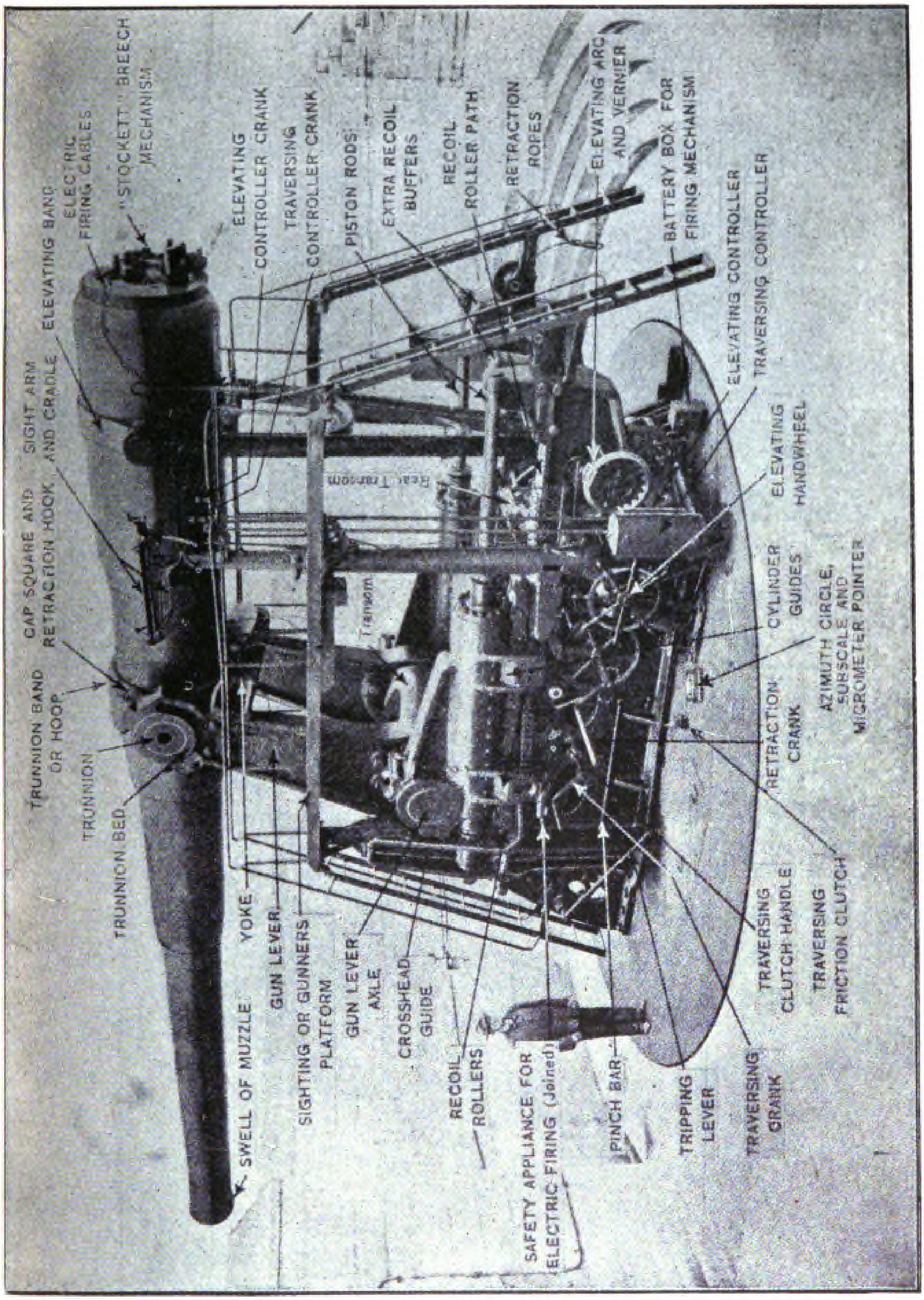
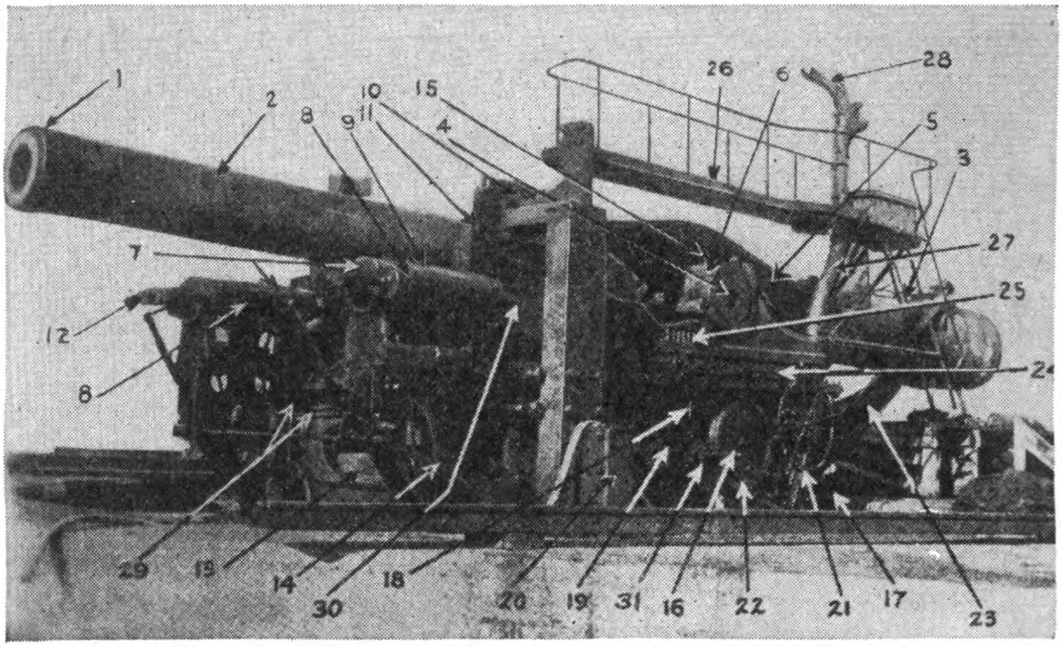


FIGURE 30.—12-inch gun M1900 on disappearing carriage M1901.

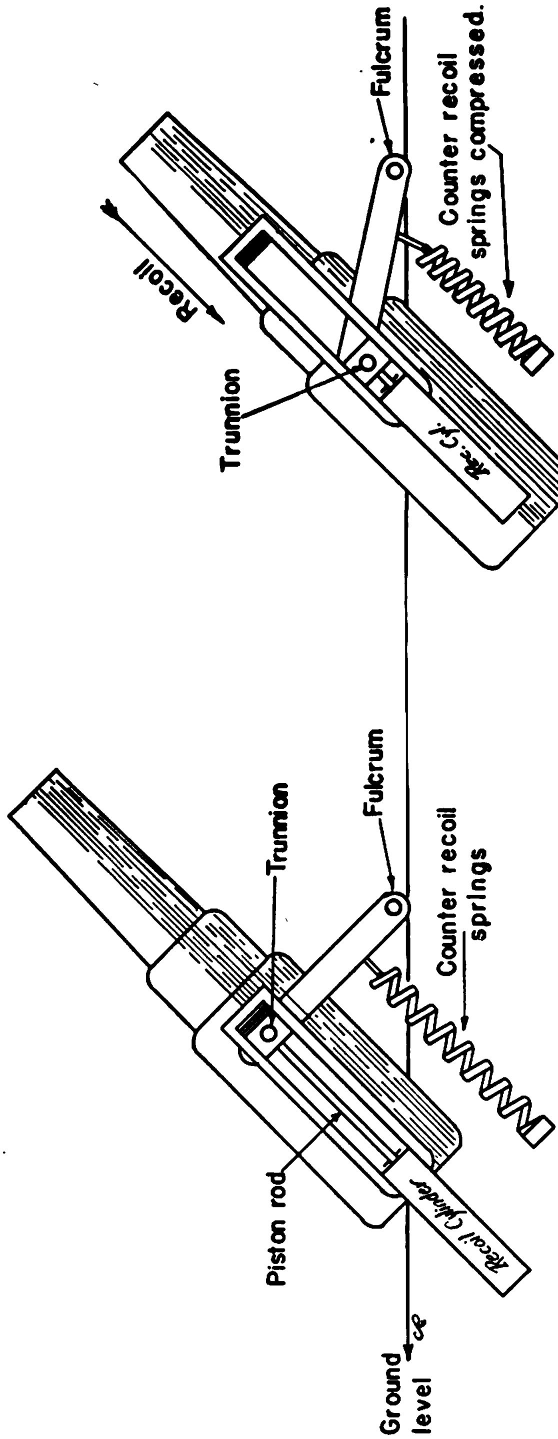


1. Swell of muzzle.
2. "C" hoop.
3. Elevating band.
4. Gun lever trunnion.
5. Upper carriage.
6. Cap square.
7. Buffer cylinders.
8. Spring cylinder covers.
9. Filler plug.
10. Cross head.
11. Recoil rack.
12. Yoke.
13. Counterweight.
14. Tripping lever.
15. Retraction hook.
16. Retraction crankshaft.
17. Retraction rope and eye.
18. Retracting clutch handle.
19. Traversing crankshaft.
20. Traversing controller.
21. Elevating handwheel.
22. Range drum.
23. Elevating arm.
24. Recoil rollers and roller cage.
25. Pinch rack.
26. Sighting platform.
27. Sight standard.
28. Sight cradle.
29. Equalizing and throttling pipes.
30. Piston rod.
31. Brake lever.

FIGURE 31.—14-inch gun M1910 on disappearing carriage M1907 (loading position).

(3) *Mortar carriages.*

Cross head guides.
Counterrecoil springs.
Elevating gear wheel.
Elevating rack.
Equalizing pipe.
Fulcrum.
Guide rails.
Pedestal bracket.
Quadrant.
Spring caps.
Spring cylinders.
Spring-cylinder support.
Spring rods.
Top carriage.
Transom.
Traversing brake.
Web.



1. NORMAL 2. RECOILED

FIGURE 32.—Schematic drawing showing recoil system for mortar carriage M1896.

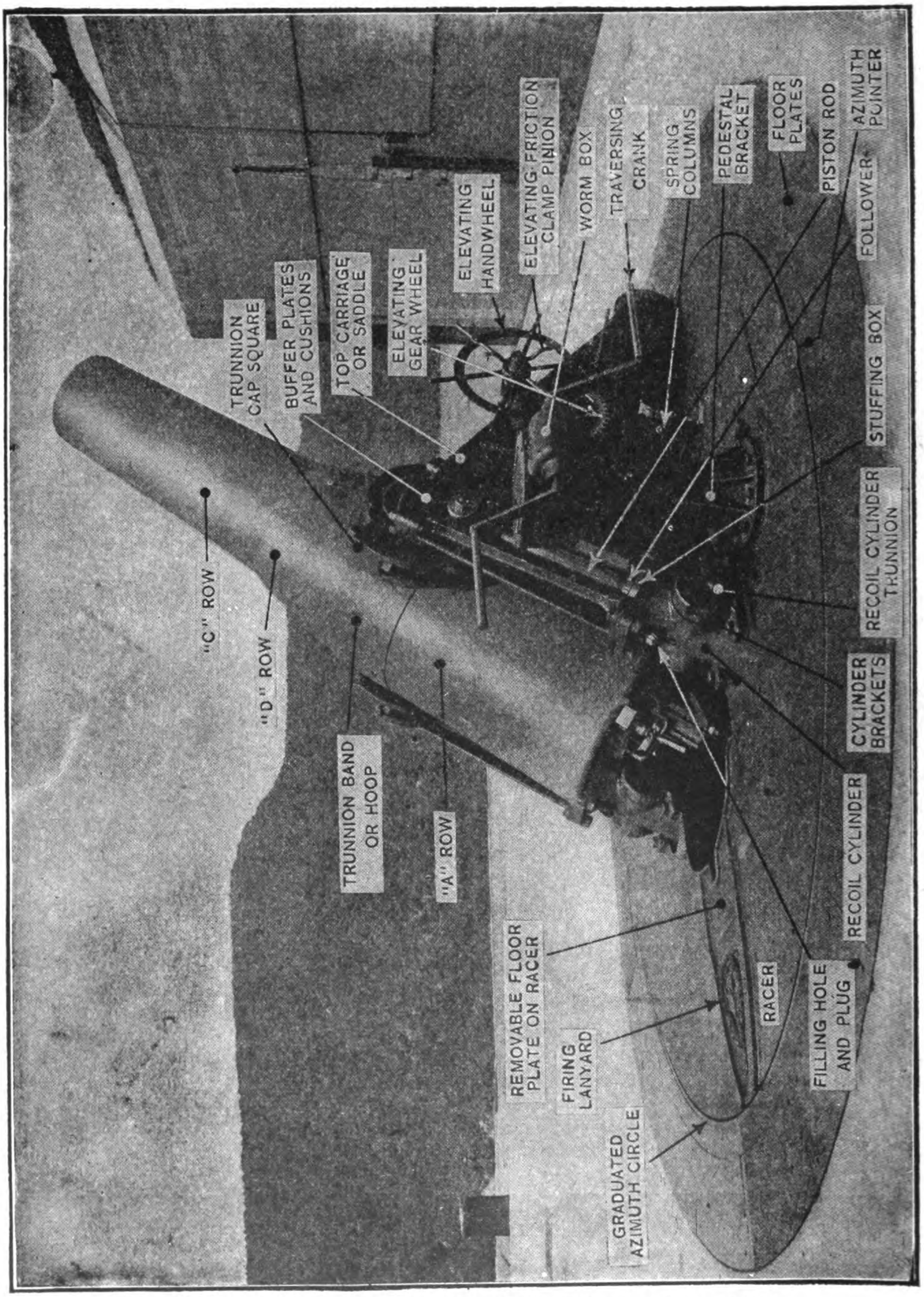
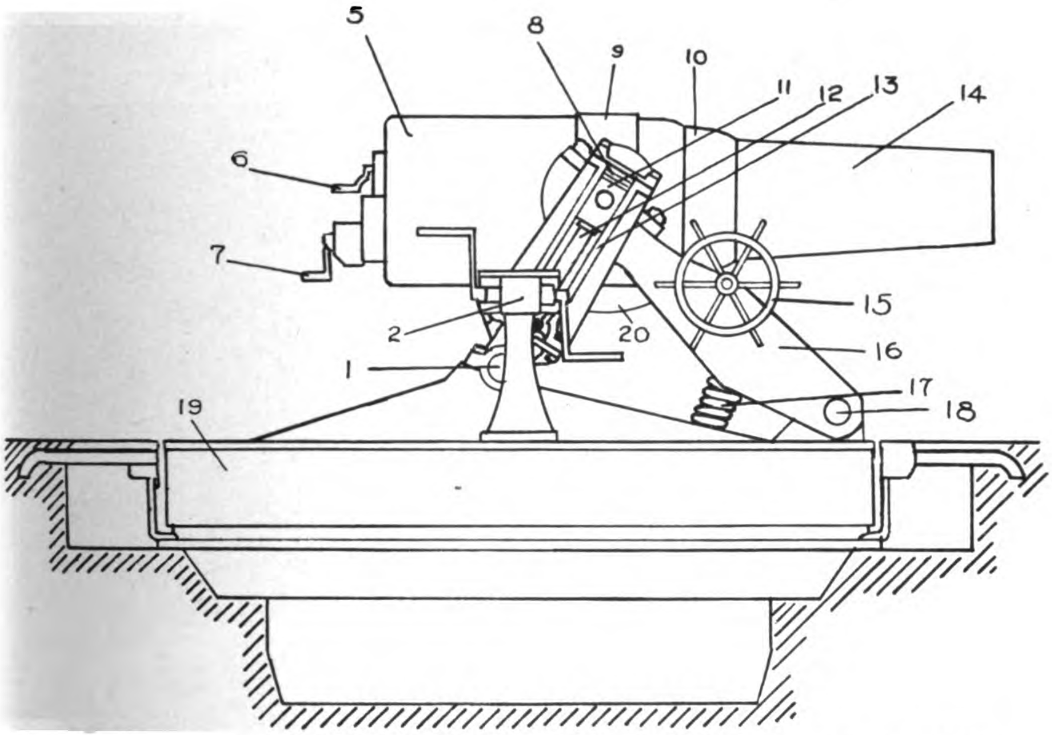


FIGURE 33.—12-inch mortar M1890MI on mortar carriage M1896.

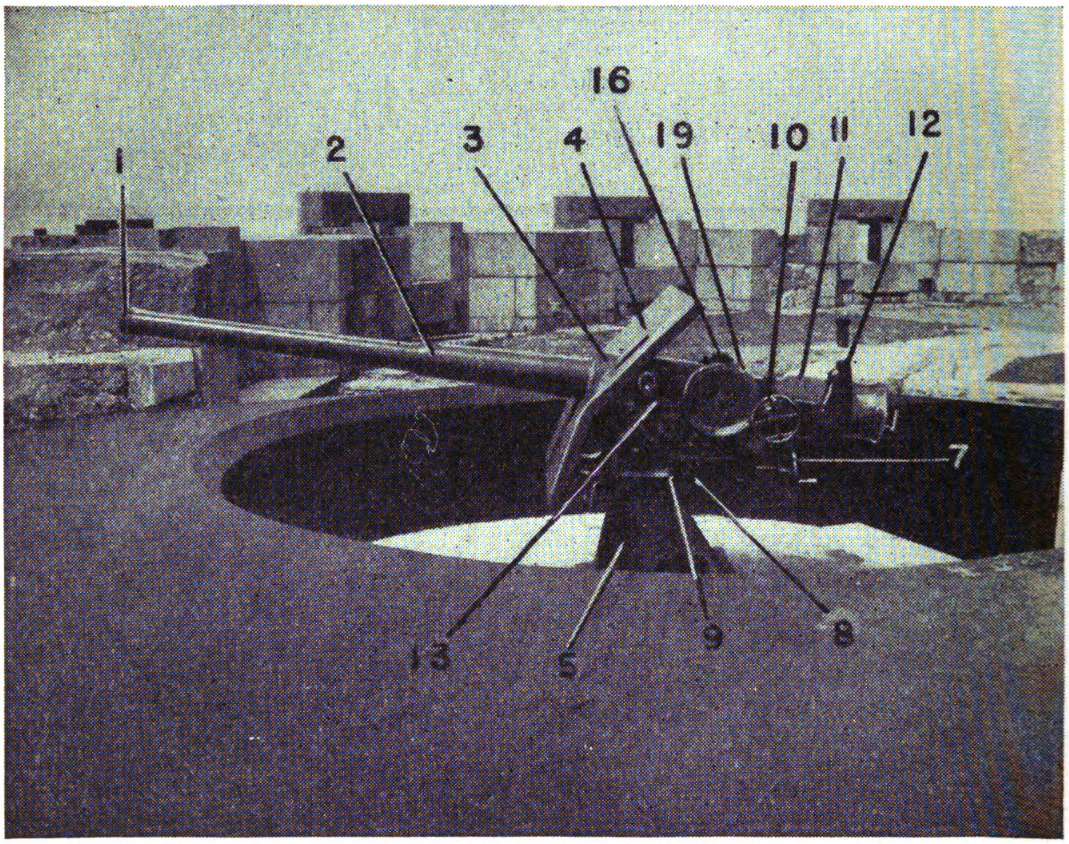


1. Cylinder trunnion.
2. Traversing mechanism.
5. "A" row.
6. Breech rotating handle.
7. Breech translating handle.
8. Buffer plates and cushions.
9. Trunnion band.
10. "D" row.
11. Cross head.
12. Piston rod.
13. Cross head guide.
14. "C" row.
15. Elevating handwheel.
16. Top carriage.
17. Recuperator springs.
18. Fulcrum pins.
19. Racer.
20. Elevation rack.

FIGURE 34.—12-inch mortar M1912 on mortar carriage M1896MIII.

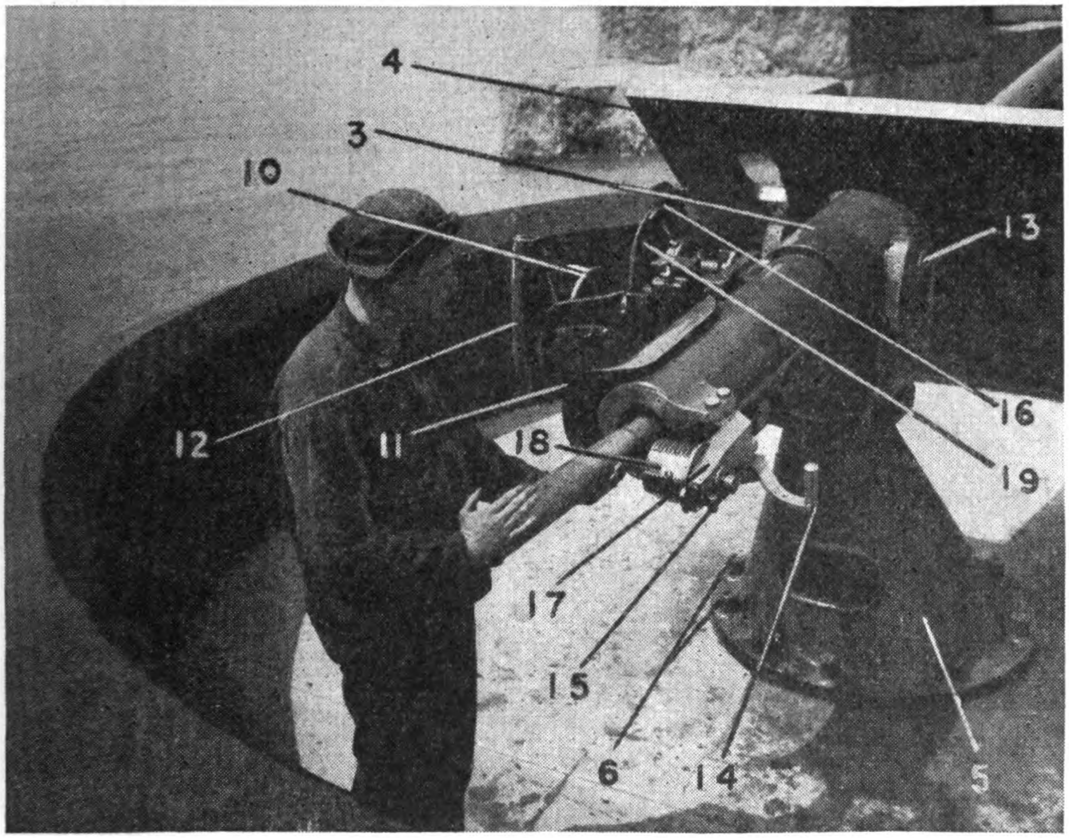
(4) *Barbette carriages.*

Antifriction elevating device.
Counterrecoil springs.
Counterrecoil spring cylinders.
Counterrecoil spring-rod piston.
Elevating buffer cylinders.
Elevating cranks.
Elevating nut.
Elevating operating layer.
Elevating rack.
Elevating screw.
Elevating screw beam.
Elevating speed indicator.
Expansion pipes.
Filling funnel.
Filling valve.
Overflow coupling.
Piston-rod nut.
Range drum brake lever.
Recoil pit.
Recuperator air chamber.
Recuperator oil cylinder.
Traversing motor.
Traversing treadle.
Waterbury speed gear.



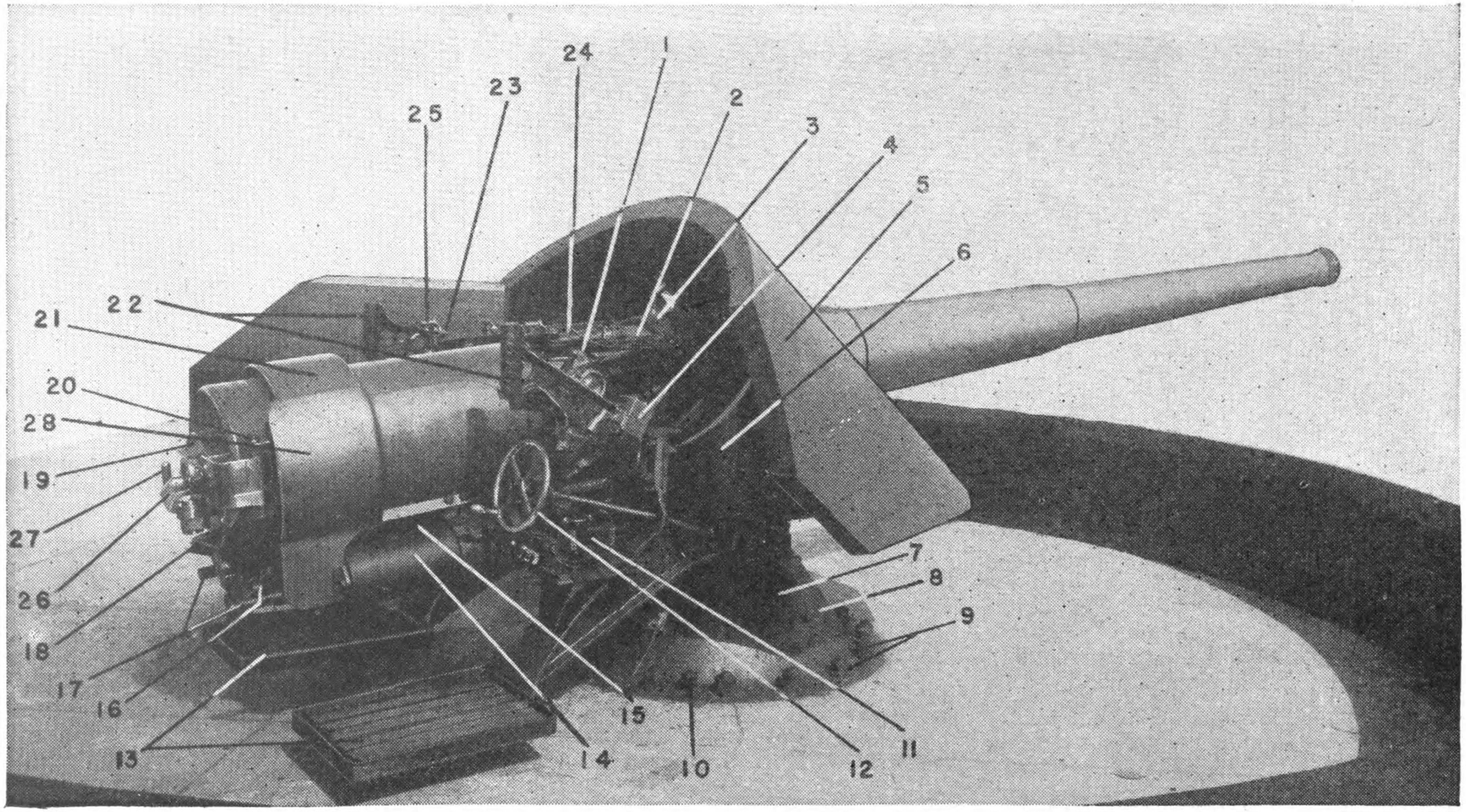
1. Muzzle swell.
2. Jacket.
3. Cradle.
4. Gun shield.
5. Pedestal.
7. Traversing handwheel.
8. Traversing worm.
9. Traversing rack.
10. Elevating handwheel.
11. Gun pointer's shield.
12. Shoulder rest.
13. Gun trunnion.
16. Sight.
19. Range disk.

FIGURE 35.—3-inch rapid-fire gun on barbette carriage (pedestal mount) (back view).



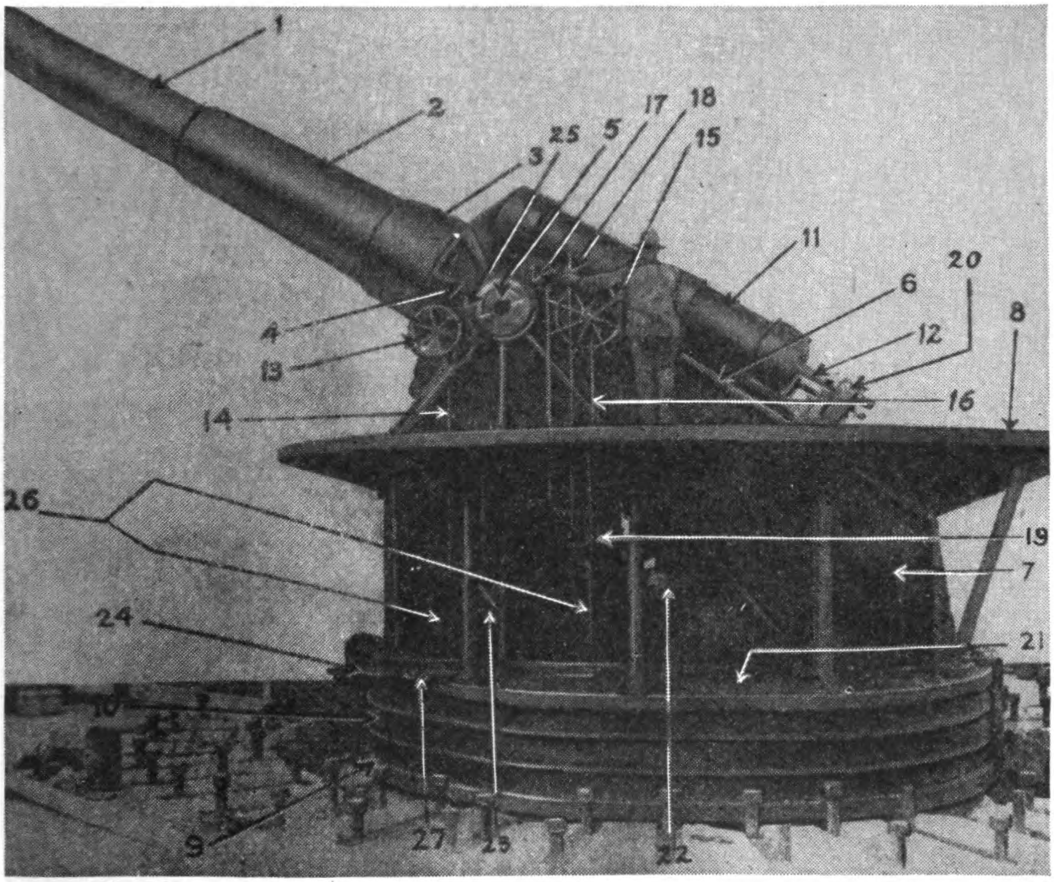
3. Cradle.
4. Gun shield.
5. Pedestal.
6. Foundation bolts.
10. Elevating handwheel.
11. Gun pointer's shield.
12. Shoulder rest.
13. Gun trunnion.
14. Breech operating handle.
15. Firing mechanism.
16. Sight.
17. Breech carrier.
18. Breechblock.
19. Range disk.

FIGURE 36.—3-inch rapid-fire gun on barbette carriage (pedestal mount) (side view).



1. Deflection screw.	8. Pedestal base.	15. Recoil cylinder.	22. Shoulder rests.
2. Sight cradle.	9. Foundation bolts.	16. Piston rod.	23. Elevation handwheel.
3. Trunnion hoop.	10. Leveling screw.	17. Spring rods.	24. Telescopic sight.
4. Firing pistol.	11. Battery case.	18. Loading tray.	25. Open sight.
5. Shield.	12. Traversing handwheel.	19. Breech carrier.	26. Gear segment.
6. Shield support.	13. Gun pointer's platform.	20. Hinge pin.	27. Breech operating handle.
7. Manhole cover.	14. Spring case extension.	21. Recoil hoop.	28. Shoulder rest.

FIGURE 37.—6-inch rapid-fire gun M1900 on barbette carriage M1900 (pedestal mount).



1. "C" hoop.
2. "D" hoop.
3. "A" hoop.
4. Cradle.
5. Cradle trunnion.
6. Side frame.
7. Chassis.
8. Top platform.
9. Base ring.
10. Distance ring.
11. Counterrecoil spring cylinder.
12. Piston rod.
13. Slow motion traversing handwheel.
14. Slow motion traversing shaft.
15. Elevating handwheel.
16. Elevating shaft.
17. Speed controller.
18. Speed indicator.
19. Electric elevating controller.
20. Yoke.
21. Racer.
22. Elevating crank.
23. Traversing crank.
24. Auxiliary platform.
25. Shoulder rest.
26. Gear boxes.
27. Azimuth indicator.
29. Recoil cylinders.

FIGURE 38.—12-inch gun on barbette carriage.

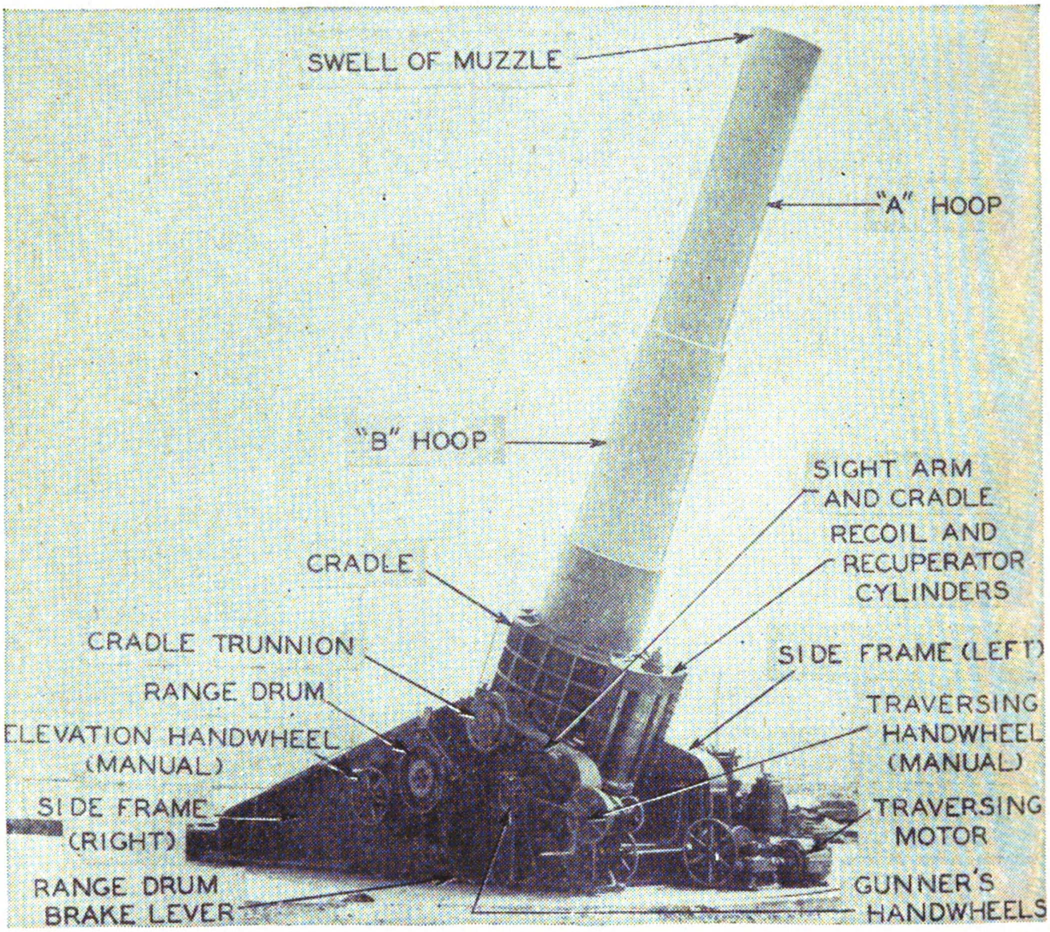


FIGURE 39.—16-inch howitzer on barbette carriage.

Section II

ACTION, CARE, AND MINOR ADJUSTMENT OF GUN AND CARRIAGE

26. General.—*a. General characteristics.*—*Q.* What is meant by caliber? *A.* The diameter of the bore of a gun or mortar between the lands of the rifling.

Q. What is the caliber of the weapon manned by your battery? *A.* ———.

Q. In what unit is the length of the bore of the gun or mortar measured? *A.* In calibers. For example, a 6-inch gun measuring 25 feet in length is said to be fifty calibers long, and a 12-inch gun measuring 40 feet in length is said to be 40 calibers long. Measurements are made from the front of the breechblock to the front of the muzzle.

Q. What is the purpose of the rifling (lands and grooves)? *A.* To make the projectile rotate so that it will keep nose first in flight.

Q. What else does the rifling cause the projectile to do? *A.* To move or drift to the right of where the piece is pointed when fired.

b. Action.—*Q.* What is the purpose of the recoil mechanism? *A.* To take up the energy of recoil and stop the gun gradually as it comes back in recoil.

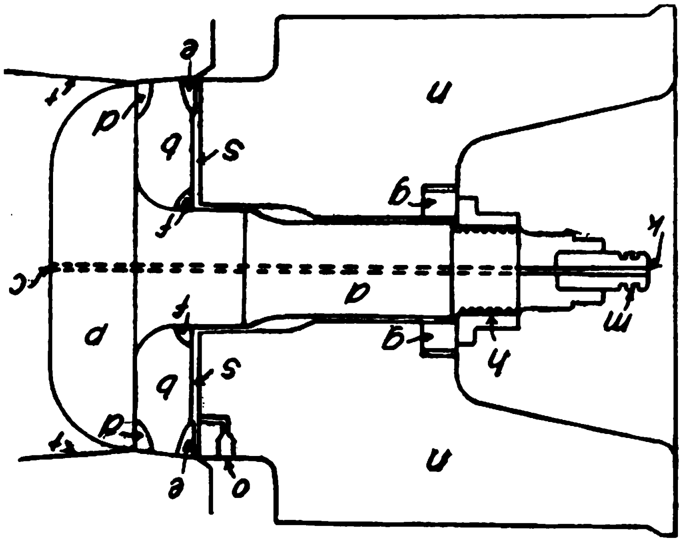
Q. What is the purpose of the counterrecoil or recuperator mechanism? *A.* To return the gun to battery after recoil.

Q. What is meant by obturation? *A.* The prevention of escape to the rear of the gases that propel the projectile.

Q. What parts of the gun or mortar provide obturation? *A.* The breechblock and the obturating mechanism.

Q. How do they function? *A.* The obturating mechanism consists of a "mushroom head" on a spindle that extends back through the center of the breechblock, a gas check pad, three metal split rings, and a filling-in disk. The gas check pad is held between the mushroom head and the filling-in disk, which is next to the front face of the breechblock. Two of the split rings are carried around the outer edge of the pad and the other is around the inner edge next to the spindle. When the gun is fired, the gases press back on the mushroom head, squeezing the gas check pad between the mushroom head

and the filling-in disk. The pad expands outward and inward, pushing the two outer split rings up against the wall of the powder chamber and the inner ring against the spindle, preventing the escape of powder gases to the rear and the loss of the lubricating substance in the gas check pad. After the pressure drops (when the projectile has left the gun), the gas check pad contracts and relieves the pressure on the split rings so that the breech may be opened. (See fig. 40.)



a. Obturator spindle.
b. Gas check pad.
c. Vent hole.
d. Front split ring.
e. Rear split ring.
f. Small split ring.
g. Ball bearing.
h. Split nut.
k. Primer seat.
m. Firing mechanism seat.
n. Breechblock.
o. Oil hole.
p. Mushroom head.
s. Filling-in disk.
t. Cannon tube.

FIGURE 40.—DeBange obturator.

Q. How is the escape of gases through the vent prevented? *A*. The primer case expands under the pressure of the gases and completely closes the vent.

Q. Remove the firing mechanism from the gun and then replace it. *A*. (Practical demonstration.)

Q. Open and close the breech. *A*. (Practical demonstration.)

c. *Care and minor adjustment*.—*Q*. What kind of oil should be used in bores of guns and as a lubricant for cross head guides and for traversing and recoil rollers and their paths? *A*. Medium rust-preventive compound.

Q. How often should recoil cylinders be drained and refilled? *A*. At least every 3 months.

Q. Why cannot recoil cylinders be allowed to remain empty? *A*. They will become dry and will rust.

Q. If water gets into the recoil cylinders, will any damage result? *A*. Yes. The cylinders will rust.

Q. What lubricant is used on gas check pads? *A*. Graphite lubricating grease.

Q. Why is the gas check pad lubricated? *A*. To prevent it from sticking which would cause injury to the pad.

Q. What care must be taken of the primer seat and vent hole? *A*. They must be washed or brushed until every trace of powder fouling has been removed and then wiped dry and oiled.

Q. What is the purpose of the sponging solution? *A*. To extinguish burning residue in the chamber of the gun before the next round is loaded. It also serves to lubricate the breech recess.

Q. What is the prescribed sponging solution? *A*. A solution of water and castile soap. If the soap solution is not available, plain water may be used.

Q. When must the bore be cleaned? *A*. As soon as possible after the gun has been fired, and every day thereafter until all "sweating" has stopped. After the bore has been cleaned, it must be thoroughly dried and then oiled.

Q. What is the prescribed bore cleaning solution? *A*. It is made by dissolving ½ to 1 pound of soda ash to each gallon of boiling water. The amount of soda ash used depends on the strength desired.

Q. What oil is prescribed for use in the bore? *A*. Medium or heavy rust-preventive compound, depending on local conditions.

Q. What precaution must be observed when cleaning and oiling the bore? *A*. Care must be exercised to prevent staves of the sponges and of the slush and cleaning brushes from rubbing against the lower portion of the bore, as excessive wear of the lands will result from this practice.

27. Guns on disappearing carriages.—*a. Action.*—*Q*. How is the recoil taken up in a disappearing gun carriage? *A*. By the oil in the recoil cylinders, the inclination of the chassis rail, and the excess counterweight.

Q. What is the object of the movable hand weights? *A*. By varying the number used, the gun may be made to go in battery properly. If it strikes the buffers hard when tripped, take off hand weights; if it fails to go clear in, add weights. Some disappearing carriages have no hand weights, but depend altogether on buffer valves.

Q. What is the equalizing pipe? *A*. A pipe connecting the front ends of the two cylinders.

Q. Why is it necessary? *A*. To keep the pressure during recoil the same in the two cylinders and thus keep the carriage from jamming.

Q. What is the connecting pipe? *A*. It is a pipe extending back from the equalizing pipe to the throttling valve, by which it is closed.

Q. What are the throttling pipes? *A*. Two pipes connecting the throttling valve with the rear ends of the two cylinders.

Q. What is the object of the throttling valve? (See note.) *A*. Its object is to control the amount of recoil of the gun.

NOTE.—In the case of disappearing carriages, models 1905 and MI and MII for 6-inch guns, and models 1907 and MI for 14-inch guns, the amount of recoil is controlled by a recoil valve contained in the piston rod. The upper end of the rod is bored axially to receive the stem and body of the recoil valve, which acts as follows: At the piston head the axial bore is surrounded by two grooves, from each of which radiate four holes, and one set of four holes opens into the cylinder on each side of the piston. Oil can therefore pass from one side of the piston to the other in two ways: by the outside of the piston head through the diametrical clearance and the throttling grooves, and by the two sets of radial holes. The passage by the two sets of radial holes is regulated by the recoil valve body, which is a bar fitting closely in the piston rod bore and having a slot cut on its outer surface, which, when the valve is entirely open, extends from one groove to the other. As the valve body is drawn upward, the portion of the slot in the valve body open to the lower groove in the piston rod bore diminishes, so that, at the end of its upward movement, the passage between the two sets of radial holes is closed. The flow of oil being thus regulated by the valve, the recoil of the gun is controlled.

Q. How does it control the recoil of the gun? *A*. By opening or closing the connecting pipe and thus regulating the flow of oil from the front ends of the cylinders to the rear ends.

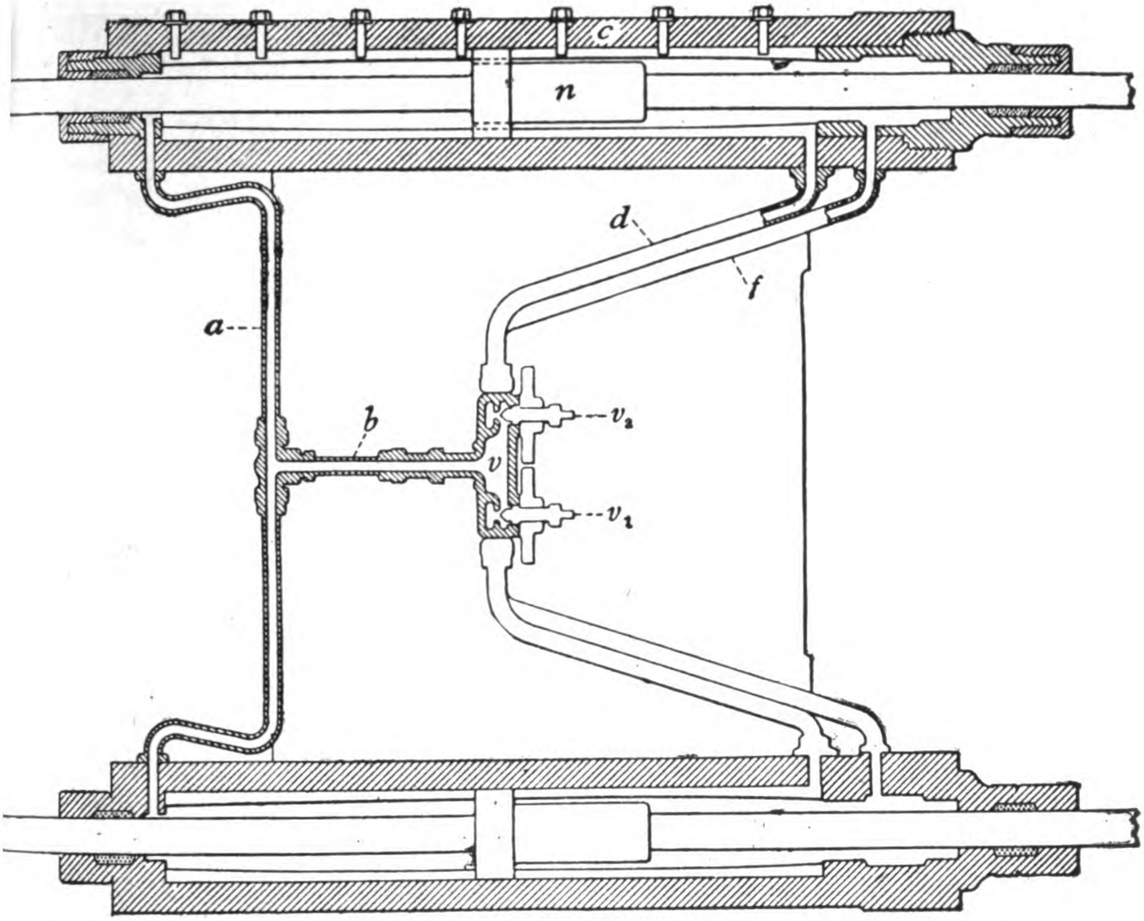
Q. What is the combined recoil and buffer valve? *A*. It is a double valve like two throttling valves, the recoil valve doing just what a throttling valve does. The buffer valve, by regulating the flow of oil from one side of the pistons to the other side, controls the last motion in counterrecoil, and indirectly has some effect on recoil. The recoil valve has no effect on counterrecoil.

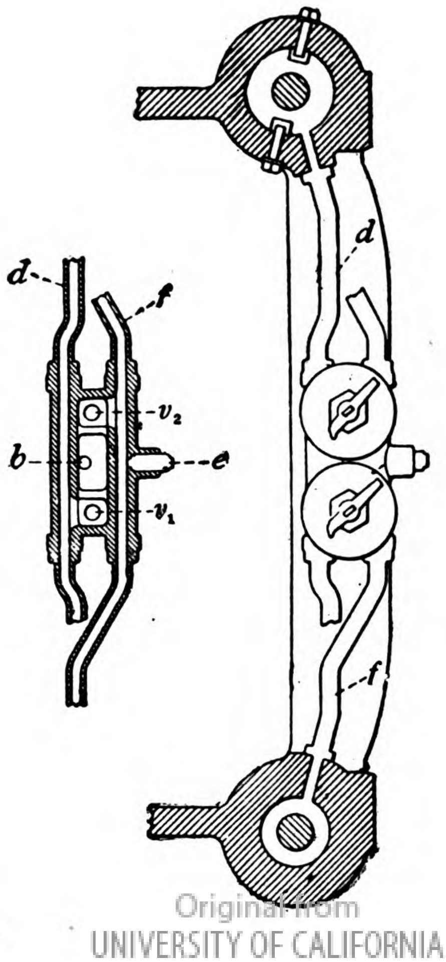
Q. How is counterrecoil accomplished? *A*. When the gun is tripped, the counterweight falls, forcing the front end of the gun lever down, causing the lever to rotate about the lever axle, and raising the gun into battery.

Q. What is the main disadvantage, from a mechanical standpoint, of the disappearing type of carriage? *A*. The guns are limited in both elevation and traverse.

b. *Care and minor adjustment.*—*Q*. What kind of oil is used in recoil cylinders of a disappearing carriage? *A*. Light recoil oil.

Q. How are recoil cylinders filled? *A*. Remove filling plugs of both cylinders and fill from one side only until they both overflow, then replace plugs.





a. Equalizing pipe.
b. Intermediate pipe.
c. Cylinder walls.
d. Recoil pipe.
f. Counterrecoil pipe.
n. Buffer lug.
v. Valve.
v_1. Recoil valve.
v_2. Counterrecoil (buffer) valve.

FIGURE 41.—Horizontal type recoil system for disappearing carriages.

Q. How are recoil cylinders emptied? *A.* By means of a valve in the equalizing pipe or the combined recoil and buffer valve.

Q. What care must be taken of the throttling valve? *A.* It must always be kept clean and free from dirt and must always be locked.

Q. What is the effect of closing the throttling valve of the —— inch carriage by one complete turn? *A.* It will lessen the recoil by about —— notches.

Q. How are the proper settings of the recoil valve and the buffer valves determined? *A.* The recoil valve, by an examination of the records of previous firing; the buffer valve, by actual trial.

Q. Should the equalizing pipe become broken, can the piece be continued in action? *A.* Yes, by closing each cylinder with a plug provided for that purpose.

Q. Should ratchet teeth on cross head guides and pawl teeth be oiled or dry for firing? *A.* Dry.

28. Mortars and their carriages.—*a. Action.*—(1) *M1896 carriage.*—*Q.* Describe the action of the elevating mechanism. *A.* The elevating rack bolted to the under side of the mortar meshes with a pinion on the shaft, which is rotated by means of gearing on a second shaft on which are the elevating handwheels. To protect the teeth of the gearing from stripping, the elevating shaft has keyed to it a friction cone, fitting into a bronze elevating gear, which is loose on its shaft. By means of a washer and nut friction may be adjusted to any degree of pressure.

Q. Point out the principal parts of the traversing mechanism and show how they function. *A.* (Practical demonstration.)

Q. What supports the top carriage? *A.* Five columns of springs at trunnion end of yoke; the yoke is pivoted at the other end in lugs on the racer.

Q. How are the springs compressed? *A.* By nut and threads on spring rods and spring compressors.

Q. How are the springs held in alinement? *A.* By spring rods.

Q. Does the spring box have motion? *A.* Yes; it has rotation.

Q. What is the equalizer pipe? *A.* A pipe connecting the lower ends of the two cylinders for the purpose of keeping the pressure during recoil the same in both cylinders and thus keeping the carriage from jamming.

Q. How is the recoil taken up? *A.* By resistance which the oil in the cylinders offers to the passage of the piston head. A small part is taken up in compressing the counterrecoil springs.

Q. How many grooves are there in each recoil cylinder wall, and why does the depth vary? *A.* There are three throttling grooves in

the wall of each recoil cylinder, the depth varying so as to give a constant pressure in the cylinders during recoil.

Q. What takes up the counterrecoil? *A*. The counterrecoil buffer.

Q. Is the M1896 mortar carriage provided with a cradle? *A*. No.

(2) *M1908 mortar carriage.*—*Q*. In what way does the M1908 mortar carriage differ radically from the M1896 mortar carriage? *A*. In the method of depressing and elevating the mortar after each shot. The M1908 mortar carriage is provided with a sleigh and cradle. The mortar may be depressed to the loading position while the sleigh and cradle remain at the firing elevation. During recoil the mortar is locked to the sleigh and recoils with it as a unit.

b. Care and minor adjustment.—*Q*. How are the recoil cylinders filled? *A*. Remove filling plugs of both cylinders and fill from one side only until the cylinders both overflow, then replace plugs.

Q. Is it necessary that the cylinders be kept completely filled with oil? *A*. Yes; if leakage occurs stuffing boxes should be readjusted and oil replaced.

Q. If the mortar does not return to battery fully, what action is taken? *A*. The counterrecoil springs are compressed by means of the adjusting nuts.

Q. Should the friction-device surfaces be oiled or dry for firing? *A*. Dry.

Q. How can you tell when the friction device is set at the proper tension? *A*. The united efforts of two men, one at each of the handwheels, should be just sufficient to cause a slipping when an attempt is made to depress below the minimum elevation.

Q. Show how the worm and gear rim are lubricated. *A*. (Practical demonstration.)

29. Guns on barbette carriages.—*a. Action.*—*Q*. What are the major advantages of barbette carriages when compared with other carriages? *A*.

(1) 360° traverse.

(2) Greater maximum elevations.

(3) High speed of operation.

(4) Simplicity and ruggedness of carriage.

Q. How is the recoil taken up? *A*. By the resistance of the recoil liquid to passage of the piston through each recoil cylinder and by the compression of the gas in the recuperator cylinder (16-inch guns and howitzers) or of the counterrecoil springs.

Q. How is the gun returned to battery after it has recoiled? *A*. by action of the counterrecoil springs or the recuperator.

Q. Of what type is the recuperator system of the 16-inch gun or howitzer? *A.* Hydropneumatic.

Q. Demonstrate how to ram a projectile with the power rammer (16-inch gun or howitzer). *A.* (Practical demonstration.)

b. Care and minor adjustment.—(1) *General.*—*Q.* What tests of the traversing and elevating mechanism should be made regularly? *A.* The carriage should be traversed and the gun elevated and depressed through the entire range of movement at least twice a month. From time to time the azimuth at which the carriage stands should be changed.

Q. At what elevation must the gun be laid when the recoil cylinder is being filled? *A.* Minimum (3-inch gun) or zero elevation.

Q. Show how to drain the recoil cylinder (or cylinders). *A.* Practical demonstration.)

Q. Show how to fill the recoil cylinder (or cylinders). *A.* Practical demonstration.)

Q. What liquid is used in the recoil cylinder (or cylinders)? *A.* A mixture of glycerin and water (16-inch guns and howitzers) or light recoil oil.

(2) *16-inch guns and howitzers.*—*Q.* How should a motor be started? *A* The controller handle should be moved slowly from the "off" to the full running position, pausing long enough on each point to allow the motor to pick up speed.

Q. If the overload switch operates, what must be done to start the motor? *A.* The controller handle must be returned to the "off" position before the motor can be started.

Q. How may the motor be operated at reduced speed? *A.* By putting the controller on one of the intermediate positions.

Q. What general care must be taken of the power rammer? *A.* It must be kept well oiled and free from dirt. The rammer head cylinder must be kept filled and the stuffing box packed to prevent leakage.

Q. What care must be taken in withdrawing a dummy projectile? *A.* The projectile must be slowed down with the extractor so as not to strike the head of the rammer chain.

Q. What care must be taken when operating the rammer chain without a projectile? *A.* It must be reversed several feet before it reaches the end of its travel, or the stop lugs on the last link will jam into the sprocket teeth and may injure the gearing. The rammer head must not be allowed to reach the rifling or the latter may be injured.

CHAPTER 4

RANGE SECTION

30. Determination of firing data.—*Q.* What are the three main steps in determining firing data for moving targets? *A.*

(1) Tracking the target.

(2) Location of the set-forward point.

(3) Calculation of firing data.

Q. Of what does each step consist? *A.*

(1) Tracking consists of locating the target with respect to the observation stations and guns.

(2) Location of the set-forward point consists of predicting where the target will be when the projectile strikes.

(3) Calculation of firing data consists of correcting the range and azimuth (or deflection) of the set-forward point for all known non-standard conditions (that is, all conditions that would cause the projectile to strike at a different point from that given by the firing tables) and, if necessary, changing the range into an elevation for use in pointing the guns.

Q. What are the three standard methods of tracking the target? *A.*

(1) Horizontal base system.

(2) Vertical base system.

(3) Self-contained base system.

Q. How is a target tracked by horizontal base? *A.* Two observation stations are selected and the azimuth and distance from one to the other are determined by survey. The line connecting the two stations is called the *base line.* The direction and distance of the directing point of the battery from one or both of the base-line stations are also determined. These three points are then located to a small scale on a plotting board in the same relative positions as on

the ground. An observer with an azimuth instrument is located in each observation station. When the time interval signal sounds, each observer determines the azimuth to the target from his station and telephones it to the plotting room. Arms on the plotting board, which are pivoted at each of the positions representing the base-line stations, are set to the azimuths received from the observers, and the intersection of the arms represents the observed position of the target, which is marked on the board. It is called a plotted point. Several plotted points define the track or path of the target, and show the speed at which it is moving.

Q. How is the target tracked by vertical base? *A.* Only one observation station is used. It is equipped with a depression position finder with which the observer can determine the azimuth and range to the target. He telephones these data to the plotting room where the station arm is set in azimuth. The plotted point is then located at the proper range by means of a range scale on the edge of the arm.

Q. How is the target tracked by self-contained base? *A.* There is only one observation station, as in the vertical base system, but two observers are ordinarily used. One has an azimuth instrument and reads the azimuth to the target; the other operates a self-contained range finder and determines the range to the target at the same time that the azimuth is read. The plotted points are marked on the board in the same way as for vertical base.

Q. What three things must be known before the set-forward point can be located? *A.*

(1) Probable path of the target.

(2) Length of time from the instant the target was at the last plotted point used in determining the firing data for a particular shot to the instant of impact of that shot.

(3) Rate of travel of the target.

Q. How is this information obtained? *A.*

(1) The probable path of the target is obtained by extending the plotted path.

(2) The elapsed time consists of the dead time plus the time of flight. The dead time is selected before tracking commences and is usually the same as the observing interval. It is the time from instant of observation to instant of firing. The time of flight is obtained by estimating the range with the help of the range to the last set-forward point.

(3) The rate of travel is obtained by measuring the distance between the last two or three plotted points and dividing by the differences between the times of observation of the first and last points considered.

Q. How is this information used to establish the set-forward point? *A*. The elapsed time is multiplied by the rate of travel, which gives the distance ahead of the last plotted point that the target will be when the projectile strikes. This distance is laid off along the probable path of the target and the set-forward point marked on the plotting board.

Q. What are the firing data? *A*. The corrected range (or elevation) and the corrected azimuth (or deflection).

Q. How is the corrected range (or elevation) calculated? *A*. The range to the set-forward point is read from the plotting board to the operators of the range correction board and the percentage corrector. The operator of the range correction board makes the range corrections according to the data given him by the range officer and calls off the correction to the percentage corrector operator. The percentage corrector operator applies it to the uncorrected range and telephones the corrected range, or the corresponding elevation, to the guns.

Q. How is the corrected azimuth (or deflection) calculated? *A*. The azimuth to the set-forward point is read from the plotting board to the deflection board operator who makes the lateral corrections according to data given him by the range officer, applies the corrections to the uncorrected azimuth, and telephones the corrected azimuth to the guns. (If deflections are being used, the travel of the target is read to the deflection board operator, who computes the corrected deflection and telephones it to the guns.)

Q. When is corrected azimuth sent to the guns? *A*. When case III pointing is employed.

Q. When is corrected deflection sent to the guns? *A*. When case II pointing is employed.

Q. On what does the accuracy of the firing data depend? *A*. On the accuracy and skill of each individual operator in adjusting and operating his board and transmitting the data. One inaccurate operation or one mistake in transmission of data by any member of the team may mean the difference between a hit and a miss.

Q. What are reference numbers? *A*. Arbitrary numbers used to represent actual values of units of measure used in seacoast artillery firing.

Q. Why are reference numbers used? *A*. To avoid the use of "plus," "minus," "up," "down," "right," and "left."

Q. What is the reference number that represents "zero" in any system called? *A*. The *normal*.

Q. Is there more than one system of reference numbers? *A*. Yes, there are several systems.

Q. Where are reference numbers used? *A*. On nearly every fire-control instrument of a battery.

Q. What do these numbers indicate? *A*. The settings determined on one instrument which are applied to the scales of other instruments marked with the same numbers.

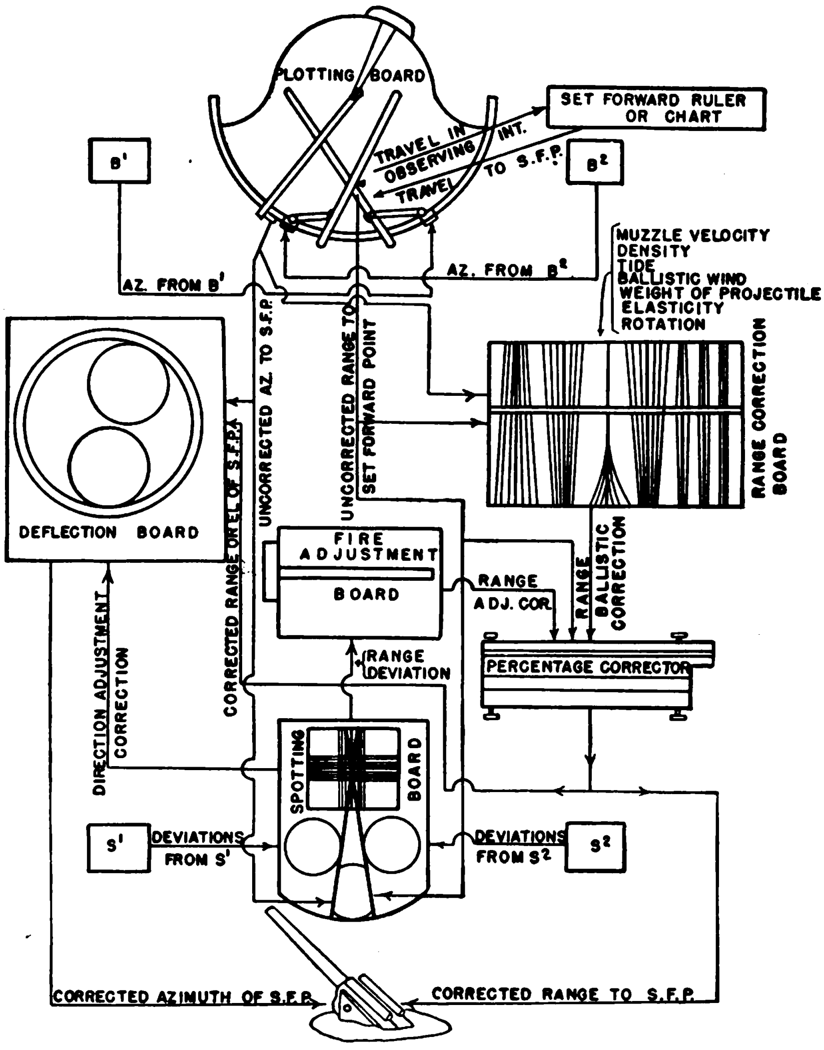


FIGURE 42.—Schematic diagram of routing of position finding data and firing data.

Q. What is the system of position finding ordinarily used in your battery? *A*. ———.

Q. Is there an auxiliary or emergency position-finding system in your battery? If so, describe it. *A*. ———.

Q. Trace the range and direction data from the plotting board to the gun, stating the operation performed at each step. *A*. (Description of method in use in your battery.)

31. Plotting boards.—*Q.* What data are obtained from the plotting board? *A.* Uncorrected range and azimuth, from the guns to the target.

Q. What care should be taken of the board? *A.* Keep the board covered when not in use. Wipe off dust frequently. Keep all parts clean. Do not handle scale arms roughly; to do so may bend them or mar the graduated edges.

Q. What is meant by a right-handed base line? A left-handed base line? *A.* See figure 43.

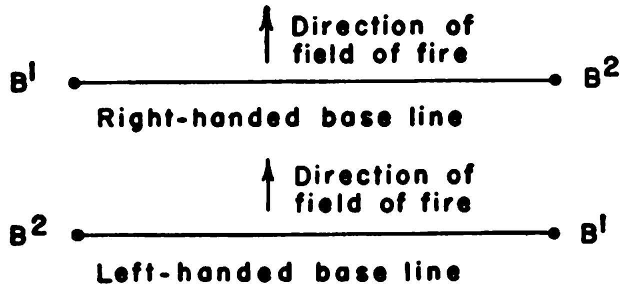


FIGURE 43.—Differentiation between right-handed and left-handed base lines.

Q. Given several points on the plot of a course shown on the plotting board, indicate a plotted point, a predicted point, and a set-forward point. *A.* (Practical demonstration.)

Q. Which point is used in determining the range and direction to the target? *A.* The set-forward point.

Q. Read the range and azimuth to the set-forward point. *A.* ——.

Q. What is the scale of this plotting board? *A.* —— yards to the inch.

Q. Lay off on the board a distance of —— yards. *A.* (Practical demonstration.)

Q. Find the distance between two given points. *A.* (Practical demonstration.)

Q. Point out the following parts:

Azimuth circle.
Base line.
Directing point.
Gun (mortar) arm.
Primary arm.
Primary station.
Secondary arm.
Secondary station.
Targ.

For practical instruction the duties of each member of the range section should be performed. (See descriptions of devices which follow.)

a. Plotting and relocating board M1923 (*Cloke*).—*Q*. Point out and state purpose of each of the following parts of the plotting and relocating board, M1923:

Arm handles.
Arm clamps.
Azimuth circle.
Azimuth strip stop.
Base-line stop.
Base-line stop slide.
Bracket.
Gun plate.
Gun slide.
Master key.
Platen.
Platen clamping lever.
Platen slide.
Platen index.
Plotting arm.
Push button (gun).
Push button (master key).
Push button (platen).
Relocating arm.
Plotting arm center and relocating arm center.
Range scales.
Rider.
Slide.
Stop clamping lever.
Verniers (degree and mils).
Vernier covers.

Q. How many sets of graduations are there on the azimuth circle? *A*. Four sets, two inside the groove and two outside.

Q. Describe the arrangement of the sets. *A*. The sets are in pairs, the inner pair for use with the plotting arm, and the outer pair for use with the relocating arm. In each pair the inner set is graduated every whole degree and the outer set every 10 mils.

Q. How do you determine which set to use in setting azimuths? *A*. The arm being used determines the pair, and the readings received from the observation station determine the set (degrees or mils).

Q. Where are the scales for hundredths of degrees and for single mils located? *A*. On the ends of the arms.

Q. What are they called? *A*. Vernier scales.

Q. How many vernier scales are there on each arm? *A*. Four.

Q. Describe the arrangement of the vernier scales. *A*. The scales are arranged in pairs, each pair for use with the particular edge of the arm that passes through the center of the azimuth circle. In each pair the inner scale is graduated every 0.05° and the outer scale every mil. Covers are provided so that all the scales except the one in use may be concealed.

Q. Why is this arrangement necessary? *A*. Because each arm may be adjusted so that either edge passes through the center of the azimuth circle.

Q. Name two methods of plotting on the Cloke type plotting board. *A*. The direct method and the offset method.

Q. Explain the direct method of plotting when a horizontal base is being used. *A*.

(1) Set the plotting and relocating arms at their respective azimuths (sent from the observation stations) and clamp.

(2) The platen slide being against its stop, and the platen being against the base-line stop, clamp the platen to the platen slide by means of the clamping lever.

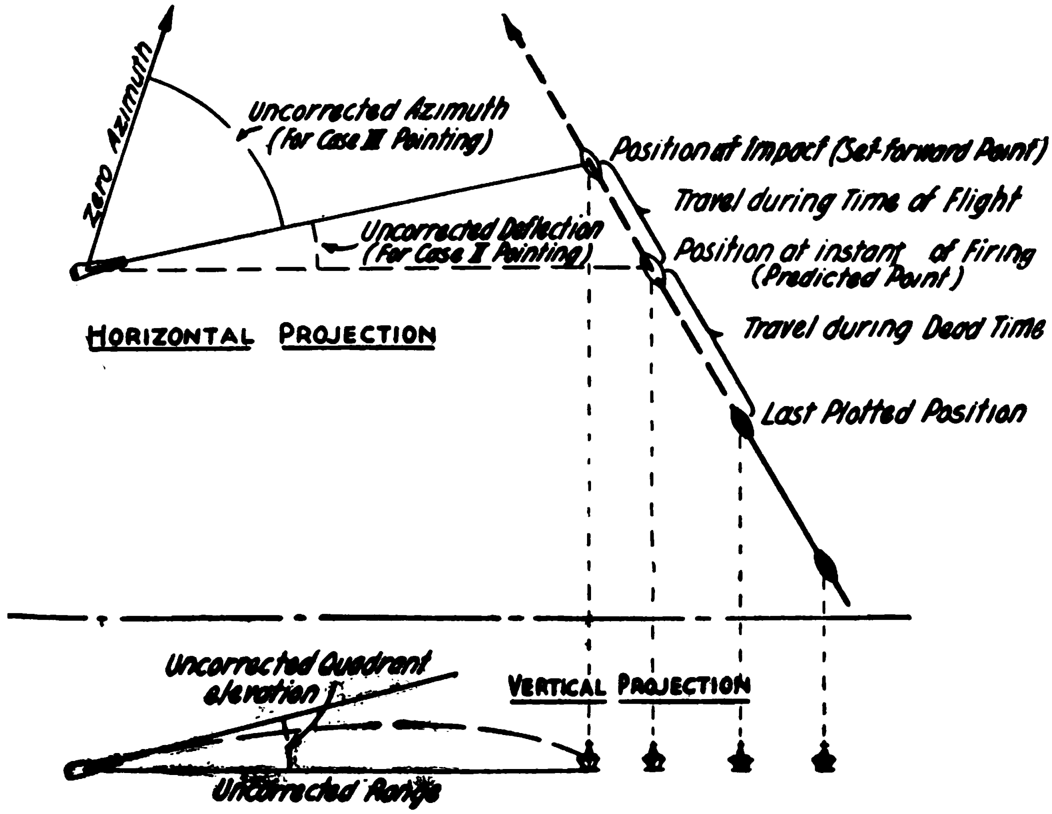


FIGURE 44.—Diagramatic representation of uncorrected firing data.

(3) Slide the platen and the platen slide along the plotting arm until the master key touches the relocating arm.

(4) Push the gun push button, thus plotting a point which represents the directing point.

(5) Clear the platen from above the plotted point and unclamp the platen from the platen slide.

(6) Place a targ on the mark made by the push button and bring up the relocating arm so that it touches the targ.

(7) Read the range and azimuth of the plotted point using the relocating arm.

Set-forward points are located in the usual way and the range and azimuth read as in (7) above.

Q. Explain the offset method of plotting when a horizontal base is being used. *A.* This method is used when there are several gun positions, and different ranges and azimuths must be sent to each gun. The gun plate with the various gun positions located on it is used instead of the gun slide. The rider is also used on the gun arm.

(1) Set the plotting and relocating arms at their respective azimuths (sent from the observation stations) and clamp.

(2) The platen slide being against its stop, and the platen being against the base-line stop, clamp the platen to the platen slide by means of the clamping lever.

(3) Slide the platen and platen slide along the plotting arm until the master key touches the relocating arm.

(4) Push the platen pivot push button, thus plotting a point which represents the position of the platen pivot.

(5) Locate a set-forward point from points plotted as above, in the usual way.

It is now necessary to obtain a setting of the oriented platen such that the set-forward points of the different guns can be located, and the ranges and azimuths of these points obtained. To do this:

(6) Place a targ at the plotted set-forward point.

(7) The platen being unclamped from the platen slide, bring the plotting arm against the targ and clamp the arm.

(8) Slide the rider along the plotting arm until the end of the rider strip touches the targ, and clamp the rider to the plotting arm.

(9) Bring the platen and platen slide back against their stops, and clamp them together by means of the clamping lever.

(10) Slide the platen slide with platen clamped to it along the plotting arm until it is brought up lightly but firmly against the rider.

(11) Place targ in turn on each gun position on the gun plate, bring the relocating arm against each position of the targ, and read the range and azimuth of each gun position in turn.

Q. Can this board be used with the vertical base system? *A.* Yes. The observation station is represented by the platen pivot. The plotting arm setter sets the plotting arm at the azimuth received from the reader of the depression position finder and repeats the range sent him by the same reader. The platen operator moves the platen slide, oriented and clamped, along the plotting arm until the platen slide index is opposite the range corresponding to that received from the depression position finder, and the plotted point is marked by pressing the gun push button. From here on the operation is identical

with the operation using the horizontal base system, and it can be used for the direct or offset method of plotting.

Q. Can this board be used with the self-contained base system?
A. Yes. The procedure is the same as for the vertical base, and it can be used for either the direct or offset method of plotting.

When the range finder is located at the directing point the method of plotting is simplified. The relocating arm setter sets his arm at the azimuth of the target while the plotter sets the targ along the relocating arm at the observed range and pushes the targ button, plotting the position of the target. Predictions based on successive

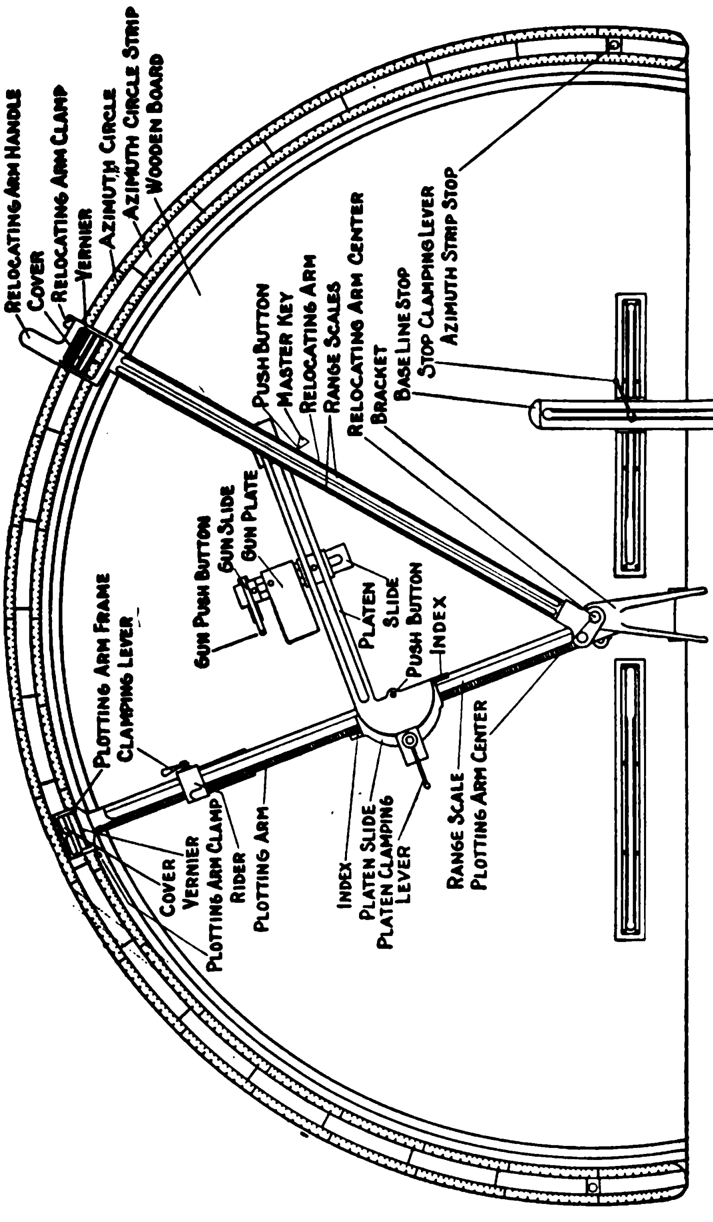


FIGURE 45.—Plotting and relocating board M1923 (Cloke).

positions of the target are made in the usual manner. The relocating arm is then used to determine the range and azimuth to the set-forward point. The platen, master key, gun slide, and gun plate are not used in this simplified method. In this method the offset method of plotting cannot be used.

b. Plotting and relocating board M1.—Q. How does the plotting and relocating board M1 differ from the plotting and relocating board M1923 (Cloke)? *A.* The boards are similar in construction and operation, practically the only difference being in the size, plotting and relocating arm scales, the graduated azimuth circle, and the base-line stop.

The M1 board is considerably larger and more sturdily built. There are four sets of scales for use with the plotting and relocating arms, namely 200, 400, 800, and 1,000 yards to the inch, giving maximum ranges of 12,800, 25,600, 51,200, and 64,000 yards, respectively. The graduated azimuth circle numbers are engraved on an endless chain actuated by a handwheel and run from 0° to 360°. The base-line stop is an adjustable slide which moves in an arc and can be clamped in any position. Some of the names of parts differ slightly from those of the M1923 board, as can be seen from the figures showing the two boards.

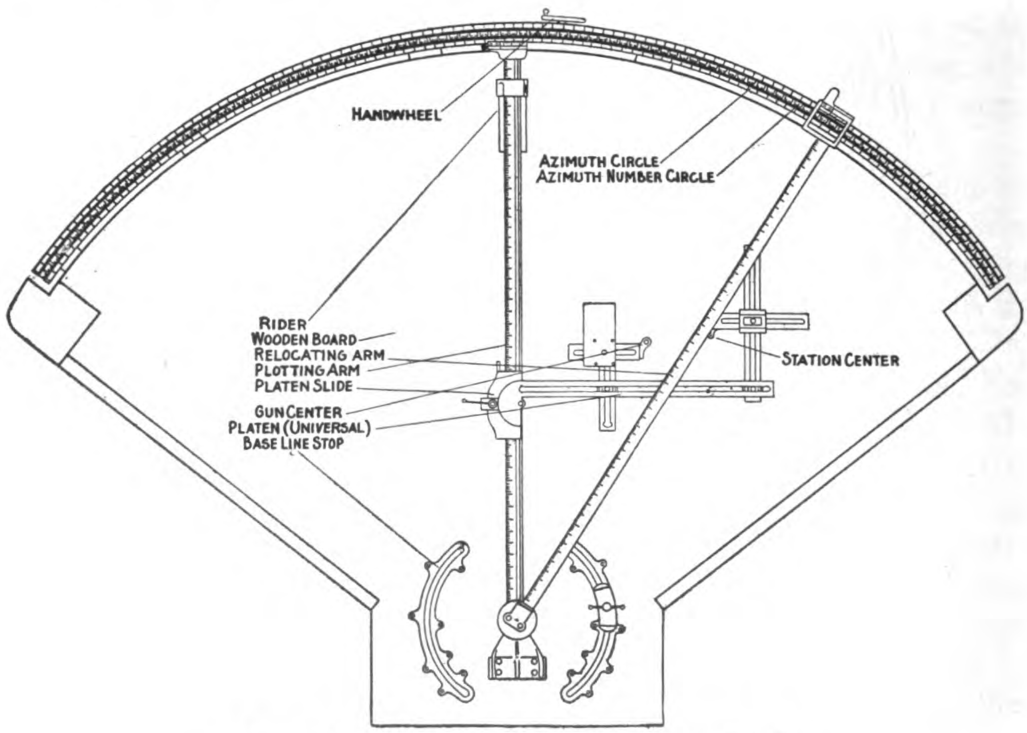


FIGURE 46.—Plotting and relocating board, M1.

c. 110° plotting board M1915.—Q. Point out and state the purpose of each of the following parts of the plotting board, M1915:

Azimuth circle.
Auxiliary azimuth circle.
Couplers.
Gun arm.
Gun arm index.
Gun arm pivot.
Gun arm subscale.
Gun center bracket.
Index boxes.
Station sleeves.
Station arms.

Q. What is the scale of the board? *A.* 400 yards to the inch.

Q. What is the value of the least reading on the gun arm? On the station arms? On the azimuth circle? On the auxiliary azimuth circle? On the index box subscales? On the gun arm index subscale? *A.* Gun arm, 10 yards; station arms, 10 yards; azimuth circle, 1 degree; auxiliary azimuth circle, 5 hundredths of a degree; gun arm index subscale, 5 hundredths of a degree.

Q. When the station arms are set in the station sleeves marked *A*, for the use of the *A* quadrant, which azimuth circle graduations are used for reading and setting the arms? *A.* The azimuth circle graduations marked *A*. Likewise the graduations marked *B* are used when station sleeves marked *B* are used, and the same for the *D* and *C* graduations.

Q. Which index box subscales are usually used for reading and setting the arms? *A.* The black subscales are used.

Q. When are the index box red subscales marked with a − 3 and a +3 used for reading and setting the arms? *A.* Only when the station arms cover the black subscale readings.

Q. How do you set the arms using the red subscales? *A.* Since these red subscales are offset 3° from the actual azimuth of the arm, 3° must be added to the azimuth sent from observation stations to obtain the azimuth at which to set the red subscale marked −3, and 3° must be subtracted from the observed azimuths to obtain the azimuths at which to set the red subscale marked −3.

Q. Explain the method of plotting using a horizontal base line. *A.* (1) Set station arms by means of the proper azimuth circle at azimuths received from observation stations.

(2) Place a targ accurately at the intersection of graduated edges of the station arm and mark on the plotting board the plotted point by pushing the targ push button.

(3) Clear station arms.

(4) Determine location of set-forward point in the usual way and mark it on the board.

(5) Place point of targ directly on the determined set-forward point.

(6) Bring gun arm lightly but firmly against edge of targ.

(7) Read range of set-forward point on the graduated scale on the gun arm, and read azimuth of set-forward point on the proper azimuth circle by means of the gun arm.

Q. Explain the method of plotting, using a vertical base or a self-contained base system. *A.*

(1) Set the station arm corresponding to observation station used, by means of the proper azimuth circle, at the azimuth received from the observation station.

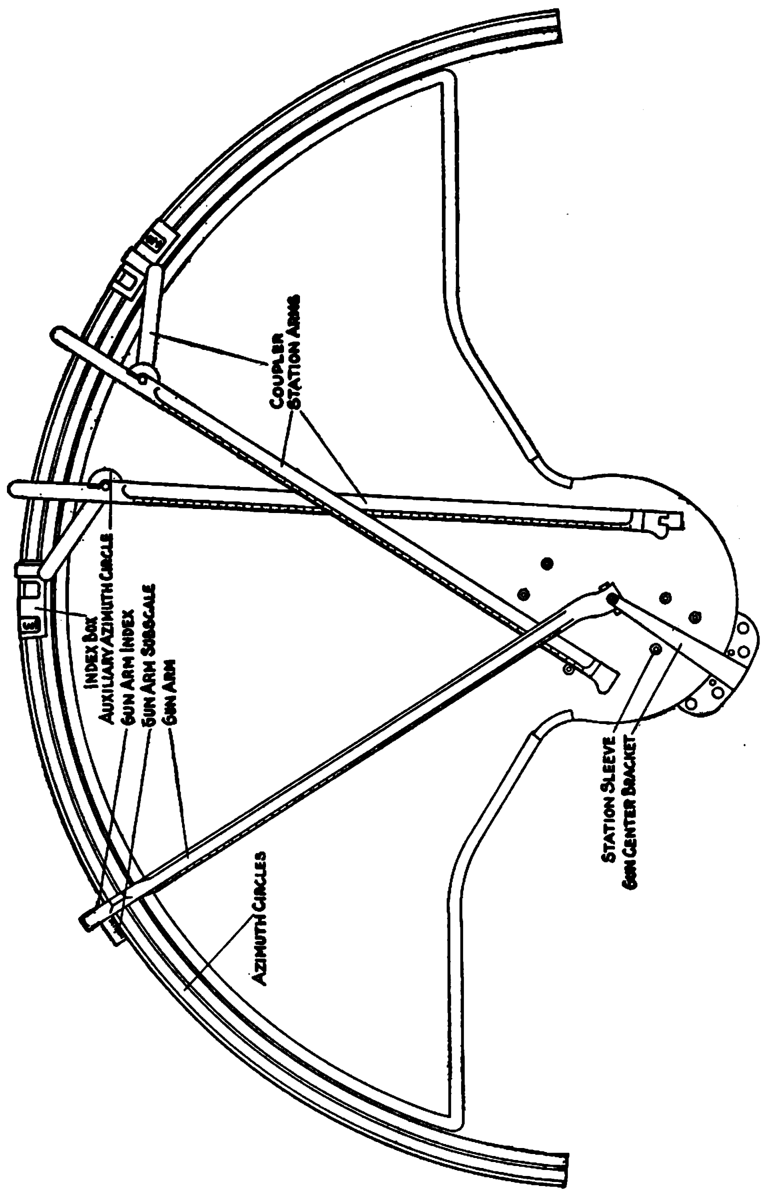


FIGURE 47.—110° plotting board M1915.

(2) Place targ against the station arm being used at the graduation on the arm representing the range received from the observation station, and mark this plotted point on the plotting board.

(3) Clear station arm.

(4) Determine location of set-forward point in the usual manner and mark this position on the board.

(5) Determine range and azimuth of set-forward point by bringing up gun arm against a targ or point and reading range and azimuth of the point.

d. 110° plotting board M1918.—*Q*. How does the 110° plotting board M1918 differ from the M1915 board? *A*. Only in size, the M1918 board being larger and capable of supplying range data up to 30,000 yards, while the M1915 board can furnish range data only to 20,500 yards.

e. Whistler-Hearn plotting board M1904 (for guns).—*Q*. Point out and state the purpose of the following parts of the Whistler-Hearn plotting board:

Auxiliary arm.
Azimuth circle.
Azimuth correction scale.
Base-line arm.
Base-line scale.
Base-line vernier.
Correction box cover.
Coupler.
Gun arm.
Gun arm azimuth circle.
Gun arm azimuth subdial.
Gun arm center.
Gun arm clamp.
Index box.
Index dial.
Index disk.
Index knob.
Lateral adjusting scale.
Locking lever.
Micrometer.
Primary arm.
Secondary arm.
Secondary station block.
Tally.
Tally subdial.

Q. How are azimuths set on this board? *A*. Whole degrees are set by means of the azimuth circle, and hundredths by means of the index box.

Q. Explain the method of plotting for case III firing, using a horizontal base line. *A*.

(1) Set the station arms to azimuths received from the observation stations.

(2) Place a targ accurately at the intersection of the graduated edges of the arms and mark on the plotting board the position of the plotted point.

(3) Clear station arms.

(4) Determine location of the set-forward point in the usual way and mark it on the board. (Predicted point is also determined if it is to be used.)

(5) Place point of targ directly on the determined set-forward point.

(6) Bring gun arm lightly but firmly against the edge of the targ.

(7) Read range of set-forward point on the graduated scale on the gun arm.

(8) Read whole degrees of set-forward point azimuth from gun arm azimuth circle scale through gun arm azimuth window, and hundredths of degrees from the gun arm azimuth subdial.

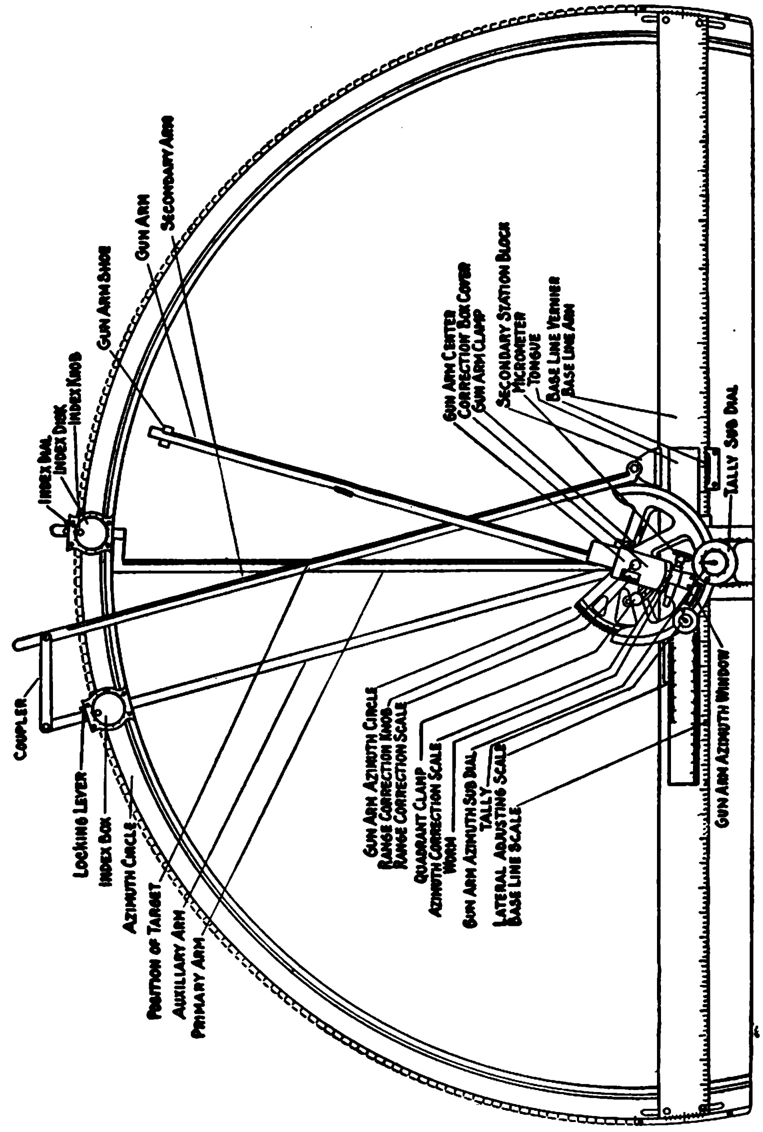


FIGURE 48.—Whistler-Hearn plotting board M1904 for guns.

The gun arm range correction scale and the azimuth correction must always be set at normal.

Q. Explain the method of plotting for case II firing using a horizontal base line when the M1905 deflection board is to be used for computing deflections. *A*. The operations are similar to plotting for case III firing.

(1) Steps (1) to (7), inclusive, are the same as for case III firing, except that when the first plotted point is located in step (3), before proceeding to step (4), bring the gun arm up against the targ held on this point and set the tally dial and the tally subdial at normal. When the next plotted point is located, again bring the gun arm up against the targ held on this point, and read the angular travel reference number from the tally dial and tally subdial and again set the two dials back to normal. The operation is repeated for each successive plotted point.

(2) Step (8) of the method of plotting for case III firing is omitted as angular travel is desired instead of the azimuth of the set-forward point.

Note.—When the deflection board M1 or the universal deflection board is to be used for determining reflections for case II firing, the operation of plotting is exactly the same as plotting for case III firing.

Q. Explain the method of plotting using a vertical base or a self-contained base system. *A*.

(1) Set the station arm, corresponding to the observation station being used, at the azimuth received from the observation station.

(2) Place targ against the station arm being used at the graduation representing the range received from the observation station, and mark this plotted point on the board.

(3) The remaining operations are the same as have been outlined for case II and case III firing using a horizontal base.

f. Whistler-Hearn plotting board (for mortars).—The operation of the Whistler-Hearn plotting board for mortars is similar to that for guns.

32. Wind component indicator.—*Q*. What is the purpose of the wind component indicator? *A*. To determine the range and deflection components of the ballistic wind for use in making wind corrections.

Q. What data are needed to operate the instrument? *A*. The azimuth and speed of the ballistic wind and the azimuth of the set-forward point.

Q. Where are they obtained? *A*. The wind azimuth and speed are obtained from the meteorological message. The azimuth of the set-forward point is obtained from the plotting board.

Q. Explain the normal operation of the wind component indicator. *A*. Set the pointer (H) on the target arm to the wind speed; turn the azimuth circle until the wind azimuth on the inner azimuth scale is opposite the pointer (K) at the lower end of the deflection component normal line; keep the target arm set to the approximate azimuth of the set-forward point by setting the index on the end of the

target arm opposite the azimuth of the set-forward point on the outer scale, changing the setting whenever the azimuth of the set-forward point differs by as much as 2½°. Read the range component reference number on the vertical scale on the grid (P) where the horizontal line that runs under the pointer (H′) hits the scale, and read the deflection component reference number on the horizontal scale

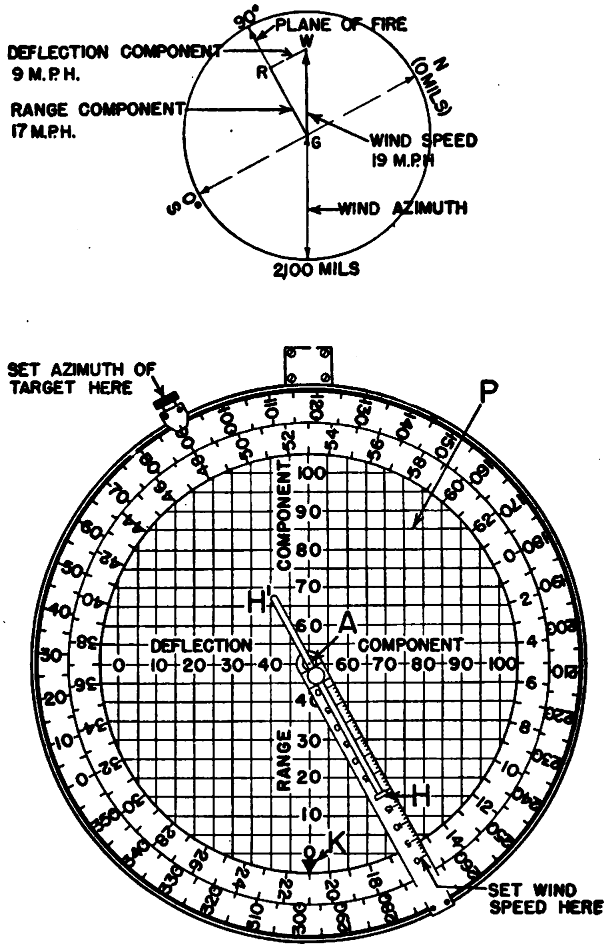


FIGURE 49.—Wind component indicator.

Where the vertical line that runs under the pointer hits that scale.

Q. If there are no lines exactly under the pointer what do you do? *A.* Take imaginary lines and estimate the nearest unit between the readings on the scales.

Q. What is the normal of the wind component reference numbers? *A.* 50.

Q. In what units and from what azimuth reference line should the target azimuth be measured? *A.* In degrees from zero south.

Q. If the target azimuth is measured from zero north how is the instrument used? *A*. The only change in operation is to set the wind azimuth opposite the upper end of the deflection component normal line instead of the lower end.

Q. Where is the range component reference number used? *A*. On the range correction board.

Q. Where is the deflection component reference number used? *A*. In the operation of the deflection board.

Q. Is the wind component indicator used when the deflection board M1 is used? *A*. No. A wind component indicator is built into the deflection board M1.

33. **Range correction boards.**—*Q*. What is a range correction board? *A*. A device for computing corrections for nonstandard ballistic conditions and adding them together algebraically for use in making a correction to the range to the set-forward point.

Q. What other information may be obtained from the charts on the board? *A*. Usually time of flight, probable error, and angle of fall, for each range.

Q. How is the accuracy of the range correction board tested? *A*. Test points are marked on the correction curves of the charts and the correction is shown on the margin of each chart. These are used to check the mechanical accuracy of the board and the accuracy of the operator.

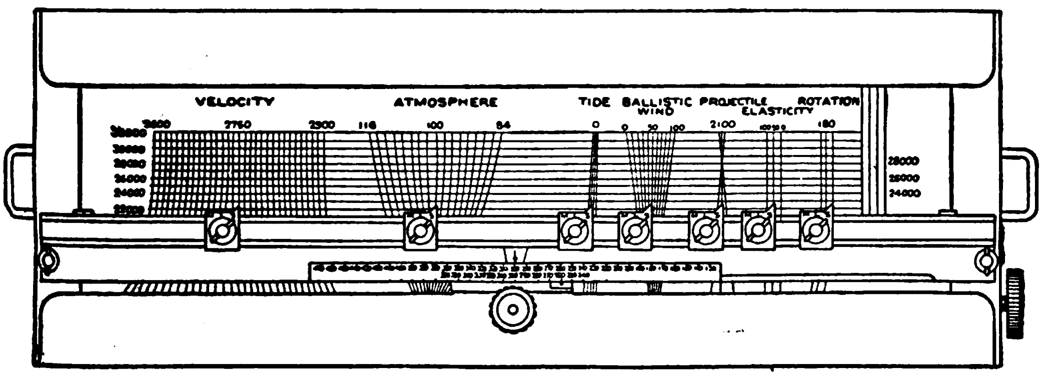


FIGURE 50.—Range-correction board M1.

Q. Are corrected ranges obtained from the range correction board? *A*. No. A correction only is obtained. This is applied to the percentage corrector.

Q. Explain the operation of the range correction board M1. *A*. The operation of the board is continuous during firing, though performed periodically. The initial ballistic correction is determined under the direct supervision of the range officer in the following manner:

(1) The range correction board operator turns the roller handle until the proper chart appears on the face of the board.

(2) The ruler is adjusted readily to bring it parallel to the range lines of any chart, simply by loosening the clamp screws and swinging one end of the ruler the necessary amount and then tightening the clamp screws.

(3) The operator turns the wing nut clamps of all movable pointers until these are at "M" on each pointer, then brings each pointer individually to the normal of its respective set of curves by means of the knob at the bottom of the correction ruler and turns the wing nut clamp of each pointer to the position "S" on the pointer. After all pointers have been set properly, he brings the index of the correction scale to the normal (300) of that scale by turning the knob at the bottom of the ruler.

(4) He records with chalk, in a convenient place in the space provided at the top of the board, the necessary data to indicate the curves to be used, these data being secured from the following sources:

(*a*) The velocity curve to be used is obtained from the range officer.

(*b*) The atmosphere curve to be used is obtained from the meteorological message.

(*c*) The height of site is obtained from the range officer, and for fixed batteries the tide is received from the tide station. In fixed batteries, charts are constructed for a definite height of site, that is, for the height of the battery above mean low tide.

(*d*) The wind reference number is obtained from the operator of the wind component indicator or the deflection board M1. This is based upon the range component of the ballistic wind for the proper maximum ordinate.

(*e*) The proper curve for the variations in the weights of projectiles is obtained from the range officer who uses, for this purpose, a table of weights prepared by the battery executive.

(*f*) The curve of temperature (elasticity) to be chosen is that indicated by the temperature in the meteorological message, or as taken from a thermometer at the battery.

(*g*) The curve of rotation to be used is that indicated by the azimuth of the trial shot point (or of the set-forward point) as called by the relocating arm setter.

(5) The wing nut clamp of the velocity movable pointer is brought to "M," and by turning the knob on the correction ruler the pointer is moved to the proper velocity curve and the wing nut clamp turned

back then to the position "S." Carry out the same process with each movable pointer, setting each pointer before proceeding to the next.

(6) The operator calls the range correction in terms of reference numbers as indicated by the index on the correction scale to the operator of the range percentage corrector where it is set on the ballistic correction scale.

As the firing continues the operator keeps the range to the set-forward point under the pointers, and shifts the pointers laterally by turning them successively to "M" and turning the operating knob whenever they deviate from the proper curve, transmitting the new ballistic correction whenever it changes by one unit of reference number. As the range component of the ballistic wind changes with the azimuth of fire, the data at the top of the board will be changed to indicate the new wind curve to be used. Likewise the data indicating the rotation curve to be used are changed when necessary.

Q. In mortar or howitzer fire, how is the board operated in changing zones? *A*. The operator must anticipate the changes in zones, setting up the board for the new zone in time to have the new ballistic correction ready when the zone is changed. The muzzle velocity to be used for the new zone will be furnished by the range officer from previous determination. Other curves will be the same as for the previous zone.

Q. How do the Pratt range correction board M1905 (modified) and the range correction board M1923 compare with the range correction board M1? *A*. These boards differ in construction from the range correction board M1 but their operation is similar.

34. Percentage corrector.—*Q*. What is the percentage corrector? *A*. A device to apply corrections to the actual range to determine a corrected range or elevation.

Q. What is the standard percentage corrector called? *A*. Percentage corrector M1.

Q. Name the principal parts of the percentage corrector M1. *A*.

Ballistic correction scale.	Ballistic pointer.
Adjustment correction scale.	Rollers.
Read pointer.	Range tape.
Index line.	

Q. Describe the different types of range charts used on the percentage corrector. *A*

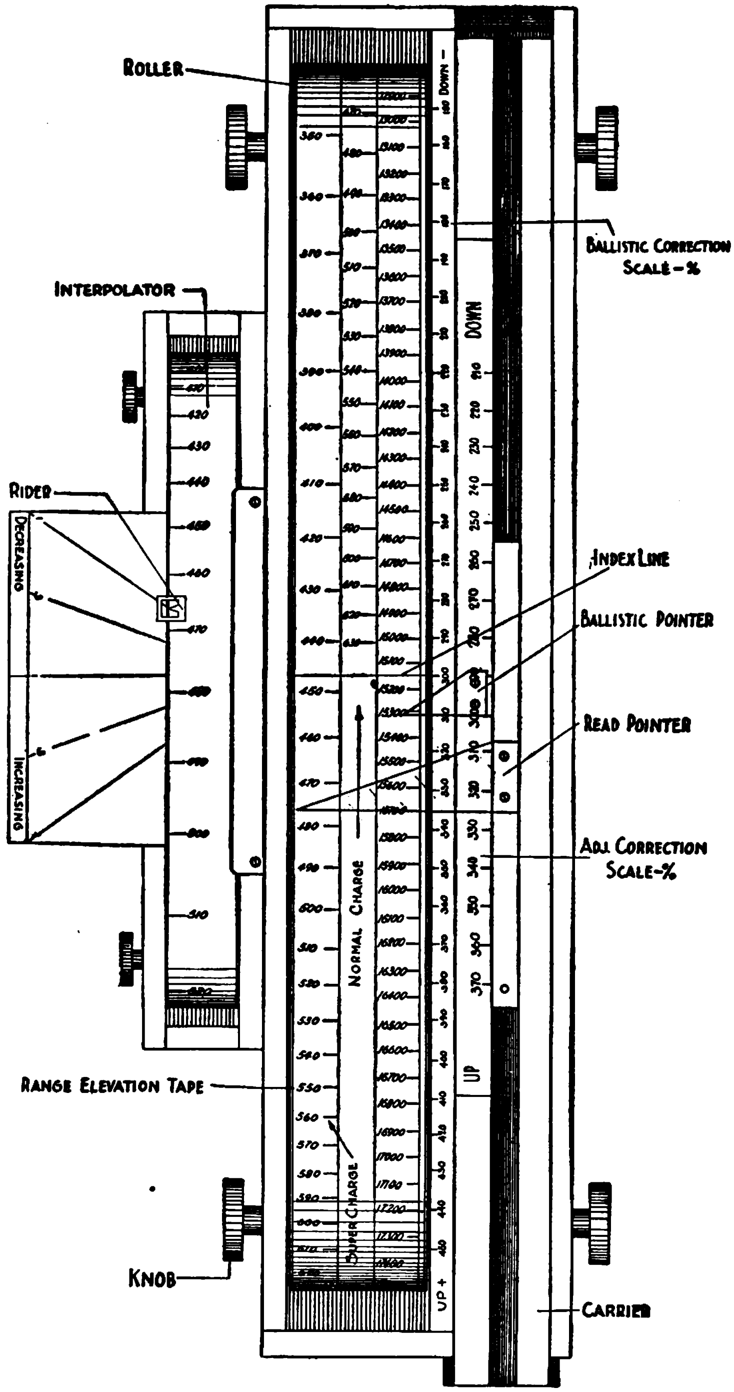


FIGURE 51.—Percentage corrector M1.

(1) For gun batteries the guns of which have range drums graduated for a particular projectile and powder charge, a single range scale is provided.

(2) For gun batteries using one weight of projectile and powder charge, when the range drums are graduated in ranges for a projectile of another weight, a range-range relation scale is furnished. The uncorrected range is set at the reading on the scale of ranges for the projectile being used. The corrected range is read from the scale corresponding to the graduations on the range drum. It is a range such that the gun will be given the proper elevation for the actual corrected range.

(3) For guns which are laid by quadrant, the chart contains a range scale, drawn parallel to which are scales of elevations for different powder charges. The uncorrected range is set on the range scale and the elevation is read from the proper elevation scale depending on whether reduced, normal, or super charge is being fired.

(4) For mortar batteries the charts have elevation scales drawn opposite the range scale on the chart. The elevation scales for two adjacent zones overlap at the points on the range scale where the zone overlaps occur, permitting a rapid change from zone to zone without shifting the chart.

Q. How are the ballistic correction and adjustment correction scales graduated? *A.*

(1) On the older types of boards the normal is marked zero and the scales are graduated in percent "up" and "down" from the center.

(2) On the newer boards, and when the range correction board scale is in reference numbers, the correction scales are graduated in terms of reference numbers, the ballistic correction scale reading the same as the correction scale on the range correction board.

Q. Explain the operation of the percentage corrector. *A.* By turning the rollers, set on the index line the uncorrected range which is the range called out by the plotter. Move the ballistic pointer until its reading edge indicates on the ballistic correction scale the ballistic correction called out by the operator of the range correction board. If there is no adjustment correction, set the "read" pointer at the normal of the adjustment correction scale; if there is an adjustment correction, move the "read" pointer until its reading edge indicates on the adjustment correction scale the adjustment correction. Read the corrected range (or elevation) opposite the reading edge of the "read" pointer on the range (elevation) scale for the proper charge and projectile and transmit the data to the guns.

Q. Explain the operation when the interpolator is used. *A*. The duties of the percentage corrector operator consist simply in setting the uncorrected ranges and the ballistic and read pointers. An additional operator operates the interpolator, wears the telephone head set, and transmits the corrected ranges or elevations to the guns.

Q. Describe the interpolator. *A*. The interpolator consists of a tape mounted on two rollers, below the tape being a piece of xylonite on which straight lines are drawn. The center line is at right angles to the tape. The other lines fan out from the center line. The reading lines on each side of the interpolator are numbered 1 and 3, and the side of the interpolator for use in determining proper interpolated range is indicated by the notation "range decreasing" and "range increasing." A rider is also attached to the tape.

Q. Describe the operation of the interpolator. *A*. On the first bell at which a corrected set-forward range is determined, the interpolator operator reads into his telephone the data indicated by the "read" pointer of the percentage corrector. He moves the interpolator tape so the data indicated by the "read" pointer of the percentage corrector are indicated on the interpolator by the central line (1) and places the rider on the tape at this point. Suppose the reading is 9,600. On the next bell on which data are sent from the plotting board, the interpolator operator reads into the telephone the new reading of the "read" pointer of the percentage corrector and moves the interpolator tape to indicate the new data under central line (1). Suppose the reading is 9,200. The rider will be moved to the right. The xylonite sheet is now moved in or out until the diagonal line (1) intersects the rider on the tape, and the rider is then moved back to the central line (1). The diagonal line for increasing range (3) indicates the proper data to be sent to the guns for the intermediate bell (the one between the bells upon which predictions and set-forward points are determined).

35. Deflection boards.—*Q*. What is the purpose of the deflection board? *A*. To compute the corrected deflection in case II firing and the corrected azimuth in case III firing.

Q. What is meant by deflection? *A*. The setting on the deflection scale of a sight such that, when the line of sight is on the aiming point, the piece is pointed in direction. In case of a telescopic sight, the aiming point is the target.

Q. In case II firing what goes to make up the deflection obtained from the deflection board? *A*. Angular travel of the target, corrections for wind and drift, and in some cases correction for rotation of the earth.

Q. In case III firing what corrections are applied to the uncorrected azimuth to obtain the corrected azimuth? *A*. Corrections for wind and drift, adjustment corrections, and in some cases correction for rotation of the earth and for azimuth difference.

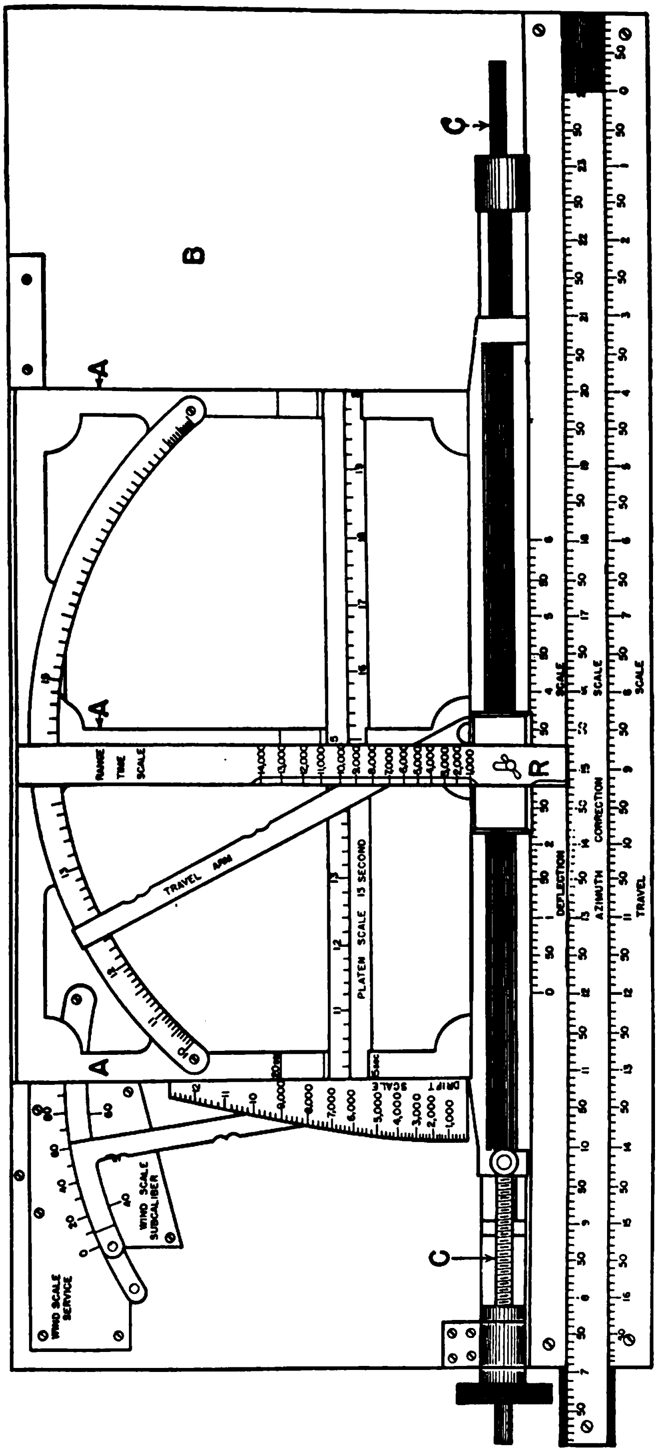


FIGURE 52.—Deflection board M1905 (for guns).

a. Gun deflection board M1905.—*Q.* Point out and state the purpose of each of the following parts of the gun deflection board M1905:

Drift scale.	Platen scale.	Travel arm.
Platen.	Range-time scale.	Wind scale.

A. See figure 52.

Q. Which edge of the wind arm or of the travel arm is read in setting off the readings? *A.* The one which would pass through the center of the pivot of the arm if prolonged.

Q. How is the board adjusted for operation? *A.*

(1) Select and put in place the proper drift scale and range-time scale for the gun and ammunition being used.

(2) Select the proper side of the platen scale and put it in its proper place on the platen, according to the length of the observing interval being used.

Q. What are the rules for adjusting the platen scale for a 20-, 30-, and 40-second observing interval? *A.*

(1) For a 20-second interval, the scale should be in the slot marked "20 sec" with the side marked "15 second" exposed.

(2) For a 30-second interval, the scale should be in the slot marked "15 sec" with the side marked "30 second" exposed.

(3) For a 40-second interval, the scale should be in the slot marked "20 sec" with the side marked "30 second" exposed.

Q. When may the curved platen scale be used? *A.* Only when the observing interval is 30 seconds.

Q. What information is necessary for the operation of this deflection board? *A.* The wind reference number, obtained from the wind-component indicator; the corrected range to the set-forward point, obtained from the range percentage corrector; and the angular travel of the target, obtained from the angular-travel computer or from the plotting board.

Q. Explain the operation of the board to obtain the deflection for the sight. *A.*

(1) Set the wind arm to the proper reference number on the wind scale.

(2) Set the platen so that the point of the drift scale corresponding to the corrected range will be accurately over the right-hand edge of the wind arm.

(3) Set the travel arm (right edge) to the travel reference number on the platen scale.

(4) Set the range-time scale so that the point of the scale corresponding to the corrected range will be accurately over the reading edge of the travel arm.

(5) Set the lateral adjustment correction (obtained from the range officer) on the azimuth correction scale at the normal of the deflection scale.

(6) The beveled edge of the range-time scale then indicates on the azimuth correction scale the deflection to be used on the sight for case I or case II pointing.

Q. How is the deflection board used in case III? *A.* The set-forward point having been located on the plotting board, its azimuth must be corrected for wind and drift before being sent to the guns. Different methods are used as different batteries. One method of using the deflection board in case III is as follows:

(1) Set the wind arm at normal of wind scale.

(2) Set zero range on drift scale.

(3) Set T-square at normal of deflection scale and clamp to platen.

(4) Set the last three figures of set-forward point azimuth on azimuth correction scale opposite the normal of the deflection scale.

(5) Set the wind arm to the wind deflection reference number and move the platen by means of the handwheel until the leaf intersects the wind arm at the corrected range to the set-forward point.

(6) Read the last three figures of corrected azimuth of the set-forward point on the azimuth correction scale under the bevel edge of the T-square.

(7) Set the azimuth of the new set-forward point on the azimuth correction scale opposite the normal of the deflection scale.

(8) Move the platen by means of the handwheel until the range scale on the leaf intersects the wind arm at the corrected range of the new set-forward point, and read the last three figures of the corrected azimuth of the set-forward point under the bevel edge of the T-square.

(9) Repeat (6), (7), and (8) for each set-forward point.

Q. How is this board adapted for subcaliber firing? *A.* The range-time scale and the drift scale are removed and replaced by the corresponding subcaliber scales. The subcaliber wind scale is used instead of the service wind scale. The operation of the board is then the same as for service firing.

b. Mortar deflection board M1906.—*Q.* Point out and state the purpose of each of the parts shown in figure 53. *A.* See figure 53.

Q. What corrections does this board apply? *A*. It applies corrections to the uncorrected azimuth for wind, drift, and adjustment. It does not apply corrections for rotation of the earth.

Q. How is the deflection chart oriented on the mortar deflection board? *A*.

(1) Bring the "Read" and "Set" pointers of the board to the same azimuth reading.

(2) Bring adjusting and lateral wind-correction scales to normal of 3.00.

(3) Fasten the deflection chart to rollers so that the zero deflection line falls immediately beneath the normal of the adjusting scale.

Q. Explain the operation of the board. *A*. (1) Unless otherwise ordered, set the lower index of the adjusting scale to the normal of the lateral wind-correction scale. Turn the handle and ratchet ring until the proper degree on the cylinder is brought into view, and set the uncorrected azimuth pointer marked "Set" to the uncorrected azimuth of the set-forward point as called out by the plotter. Turn the rear rod knob until the horizontal line representing the corrected elevation, obtained from the percentage corrector, coincides with the fiducial edge of the adjusting scale. Turn the slide knob until the arrow of the adjusting scale points to the proper curve representing the cross-wind component reference number, as obtained from the wind-component indicator. Read the corrected azimuth of the set-forward point under the "read" pointer. As changes occur, move the chart to the new corrected elevation and the arrow to the new cross-wind reference number.

(2) If the wind measurements are not available, the pointer (normal) of the adjusting scale may be set on the wind curve representing a deflection wind reference number of 50 (normal, or zero, wind correction), thus correcting for drift alone.

(3) Corrections resulting from observation of fire are applied on the lateral wind correction scale. Move the adjusting scale right or left until the lower arrow of the scale coincides with the proper graduation on the lateral wind correction scale, as indicated by the correction ordered. This correction is in reference numbers with normal of 3.00.

(4) On this deflection board adjustment corrections are applied as flat angular corrections, which is satisfactory for low angle fire. When used for mortars the azimuth adjustment slide rule should be used also to give the appropriate correction for changes in elevation.

Q. How is the board adjusted for subcaliber firing? *A*. By substituting the proper wind and drift chart.

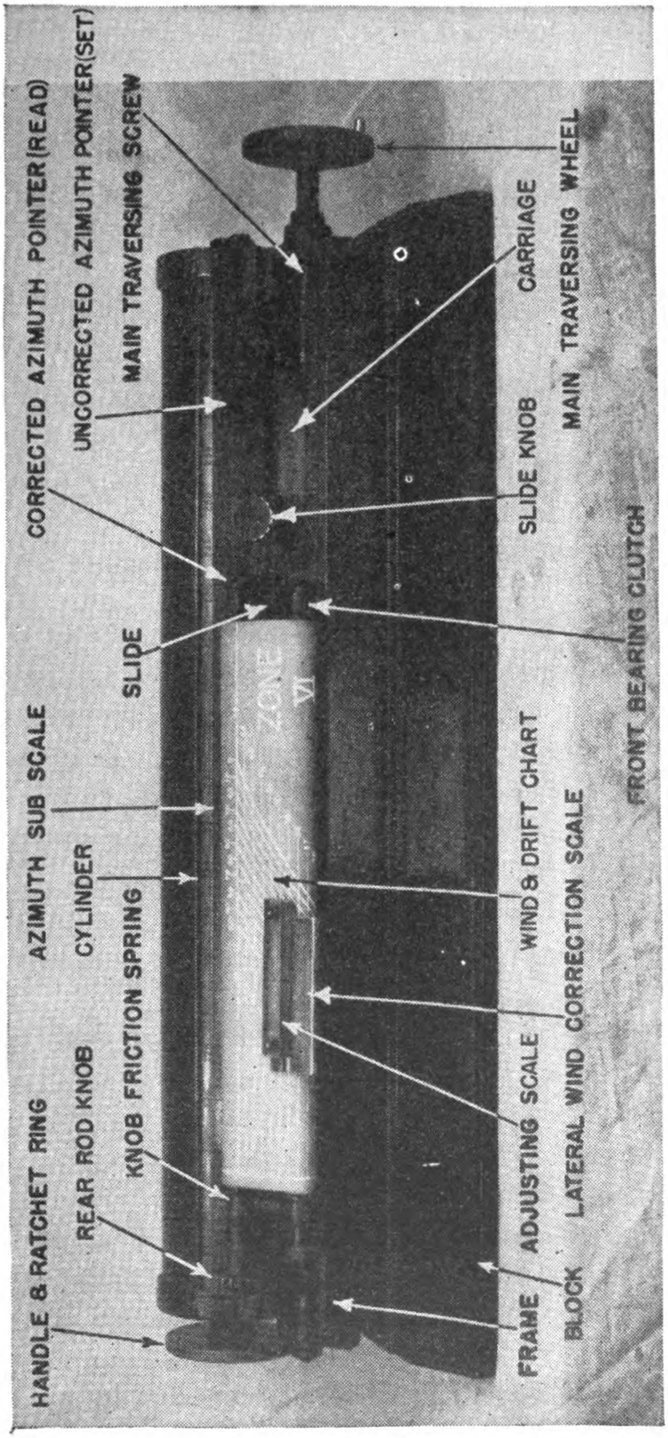


FIGURE 53.—Mortar deflection board M1906.

c. Universal deflection board.—*Q.* Point out and state the purpose of each of the parts shown in figure 54. *A.* See figure 54.

Q. What corrections are applied on the universal deflection board? *A.* Corrections for drift, wind, rotation of the earth, and adjustment resulting from observation of fire.

Q. What data are necessary to the operation of the board for case III firing? *A.* Uncorrected azimuth of the set-forward point, deflection wind-component reference number, corrected range or elevation, and the adjustment correction to be applied as a result of observation of fire.

Q. Explain the operation of the universal deflection board in case III firing. *A.*

(1) The plotter having announced the approximate range to the target and whether moving from right to left or left to right, wind as much of the azimuth tape as possible on the roller on the side toward which the target is moving.

(2) Set the pointer arm at the corrected range to the set-forward point.

(3) Set the rider (for the rotational correction) at the curve corresponding to the approximate azimuth of the set-forward point.

(4) The wind-and-drift curve to be used is determined by the deflection wind component obtained from the wind-component indicator. With the adjustment correction scale at zero, move the carrier, with arm, until the wind-and-drift correction pointer is brought to the proper wind-and-drift curve.

(5) Thereafter, keep the pointer arm set at the proper elevation, the rider on the proper rotational curve, and the pointer on the proper wind-and-drift curve.

(6) Set the slide to indicate the hundreds of degrees azimuth of the set-forward point.

(7) Move the tape so that the azimuth of the set-forward point called out by the plotter is set opposite the set index.

(8) Read the corrected azimuth on the tape opposite the read index.

Q. Explain the operation of the universal deflection board in case II firing. *A.* For use in case II firing, azimuth tapes for the universal deflection board carry at one end scales graduated to correspond to the graduations of the deflection scales of telescopic sights, except that the azimuth tape scale is numbered from left to right.

(1) See that the adjustment correction slide is set at normal or at the adjustment correction ordered.

(2) Move the tape by rolling it up on the left roller until the scale with the same normal as that of the sight being used comes into position for use on the board.

(3) Move the azimuth tape until the angular travel reference number, as received from the operator of the angular travel computer, is under the set index.

(4) Move the pointer arm until its index is set at the corrected range to the set-forward point.

(5) Move the rotation correction rider until it coincides with the proper curve corresponding to the azimuth of the set-forward point.

(6) Move the wind-and-drift correction pointer by moving the carrier to the right or left until the index of the pointer is over the proper wind-and-drift curve.

(7) The corrected deflection is read on the tape under the read index.

Q. How are adjustment corrections applied to the universal deflection board? *A*. Through the adjustment correction slide, which is graduated in 0.05° spaces to right and left of normal (zero correction). The direction in which the slide is to be moved to make the correction is indicated by an arrow on the slide.

(1) Set the movable slide coincident with the fixed index of the adjustment correction slide and opposite its normal (zero correction).

(2) Move the adjustment correction slide in the proper direction until the amount of the correction is read opposite the fixed index and the marker.

(3) The set index has been displaced by the amount of the correction, and readings made on the azimuth tape opposite the read index will give corrected azimuth, which includes the adjustment correction.

(4) Move the reference pointer so that it will again be opposite the normal of the adjustment correction slide.

(5) Apply additional adjustment corrections with reference to the index of the marker, and after the corrections have been accomplished always move the marker until it is again opposite the normal of the adjustment correction slide.

d. Angular travel computer.—*Q*. What is the purpose of the angular travel computer? *A*. To determine the deflection due to angular travel (called the "angular travel reference number") for case II pointing.

Q. Point out and state the purpose of each of the following parts: azimuth scale; median line; deflection scale; travel arm. *A*. See figure 55.

Q. How is the board adjusted for operation? *A*. By mounting the proper range-time scale, according to the gun and ammunition being used, and the proper deflection scale, according to the deflection graduations in the telescopic sight.

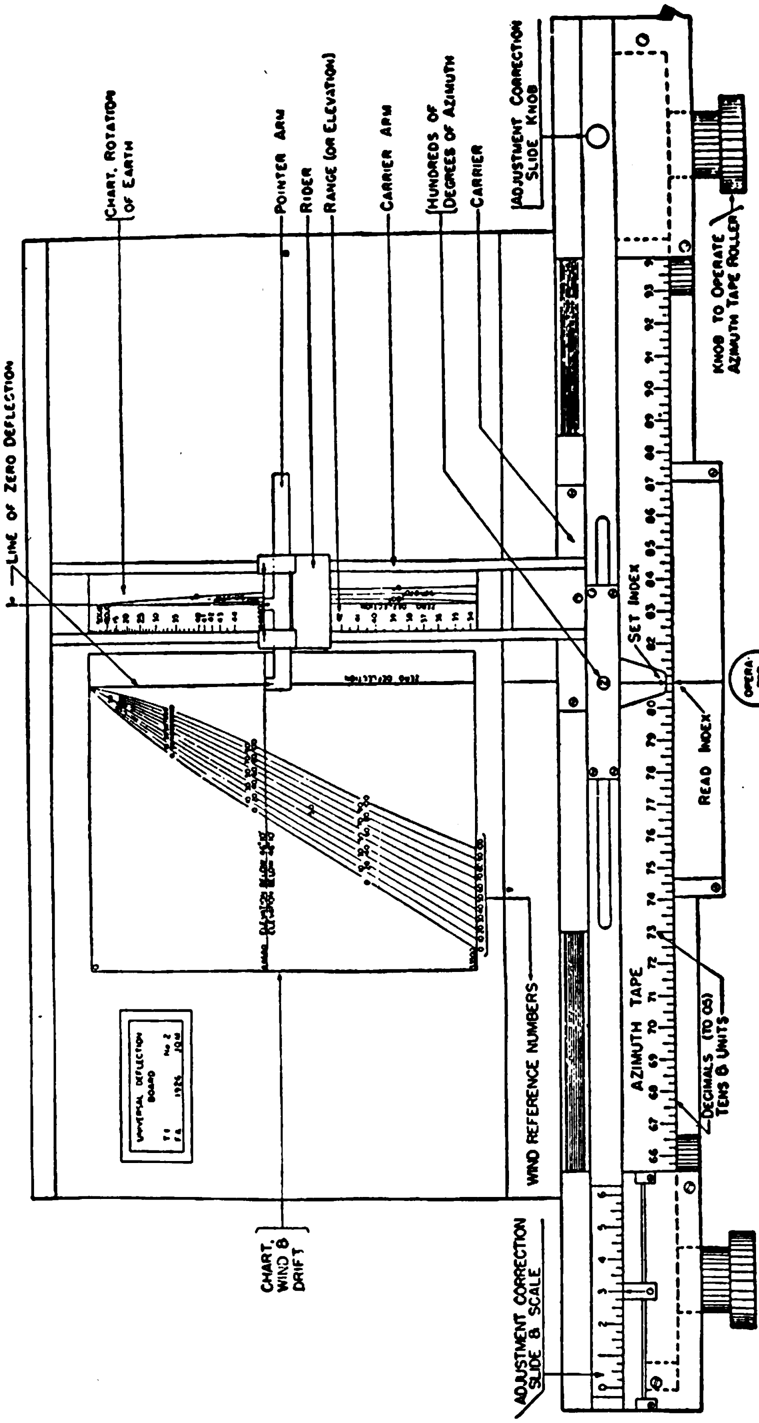
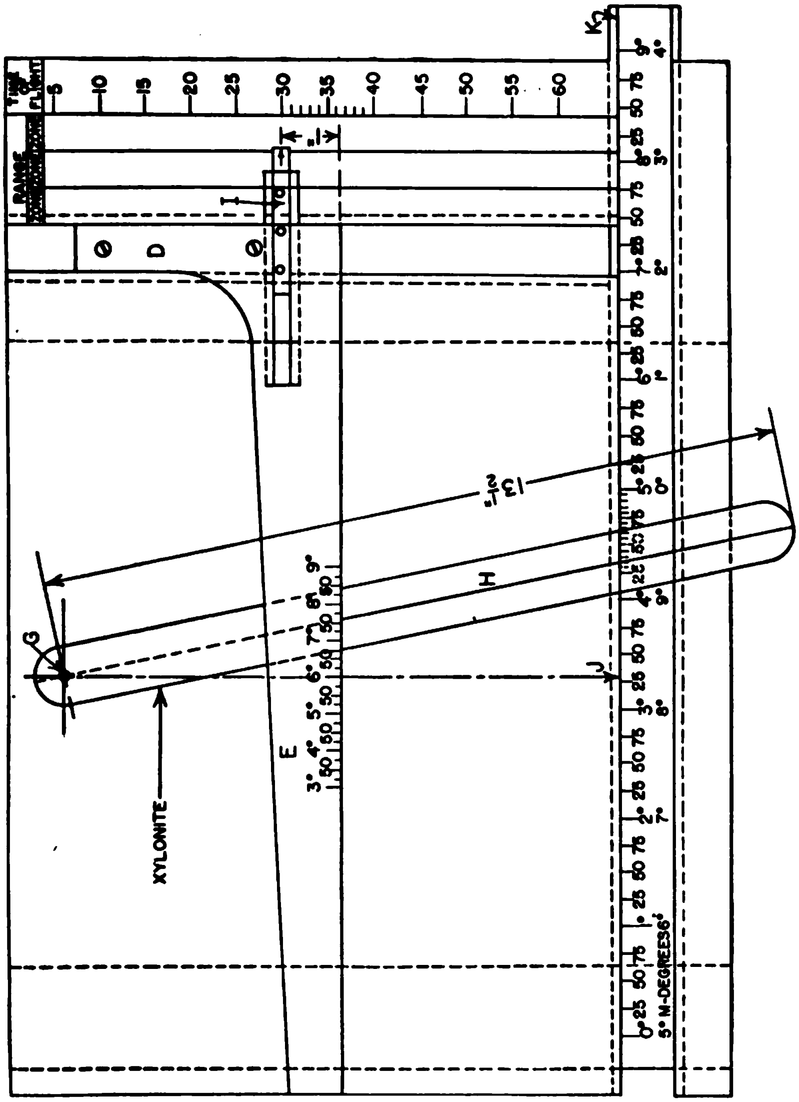


FIGURE 54.—Universal deflection board.

Q. What data are necessary for the operation of the board? *A.* The corrected range of the current set-forward point and the uncorrected azimuths to the current set-forward point and the next preceding one.

Q. Explain the operation of the angular travel computer. *A.*



D. Slide.
I. Range index.
H. Travel arm.
K. Platen scale.
E. Deflection scale.
M. Azimuth scale.
G–J. Median line.

FIGURE 55.—Angular travel computer.

(1) Set the azimuth scale so that the uncorrected azimuth (last three numbers) of the next preceding set-forward point is opposite the median line of the board.

(2) Set the pointer on the T-square opposite the corrected range to the current set-forward point.

(3) Set the travel arm to the uncorrected azimuth of the current set-forward point.

(4) Read the angular travel reference number indicated by the travel arm on the deflection scale.

Q. How is the board adjusted for subcaliber firing when the same time interval is to be used? *A*. By substituting the proper range-time scale.

Q. Can the same deflection scale be used if the observing interval is changed? *A*. No, because it is constructed for a particular observing interval.

e. *Deflection board M1.*—*Q*. What is the present standard instrument for determining the corrected azimuth or the deflection for seacoast artillery firing? *A*. The deflection board M1.

Q. What corrections are applied on this instrument? *A*. Corrections due to wind, drift, rotation of the earth, travel of the target, and adjustment corrections.

Q. Can it be used for both case II and case III firing? *A*. Yes.

Q. Can it be used for both mobile and fixed seacoast artillery? *A*. Yes. It can be adjusted to operate in either degrees and hundredths, or in mils, by a replacement of gearing and a change of scales and correction curves.

Q. What is the purpose of the wind resolving mechanism? *A*. It is for the purpose of splitting the ballistic wind up into its range and deflection components. It takes the place of the wind component indicator.

Q. Is it necessary to reset the wind resolving mechanism as the azimuth of the target changes? *A*. No. Once the wind speed and direction are set, the wind arm rotates with the main azimuth plate and scale as the target moves in azimuth. The wind reference numbers, representing the range and deflection components, are read from the face of the top plate of the wind resolving mechanism.

Q. Explain how to set and read the wind resolving mechanism. *A*.

(1) Set the "read" pointer to the speed of the ballistic wind on the wind arm.

(2) Set the wind azimuth pointer to the azimuth (from zero north) of the ballistic wind using the index (N) on the same end of the wind arm as the wind speed scale if target azimuths are measured from north; if target azimuths are measured from south, use index (S) on the opposite end of the wind arm from the wind speed scale to set wind azimuth.

(3) Under the "read" pointer on the top plate, read the range and deflection components of the ballistic wind.

Q. Explain how to set uncorrected azimuth on the instrument. *A.* Rotate the main azimuth plate and scale until the proper number of hundreds and tens of the azimuth to be set are opposite the target index (on the wind resolving mechanism); set the units and hundredths of the azimuth on the main azimuth scale opposite the azimuth setting index (above the wind and drift curves).

Q. How do you set in a correction for wind and drift? *A.* Corrections for wind and drift are combined into one set of curves on the ballistic correction chart.

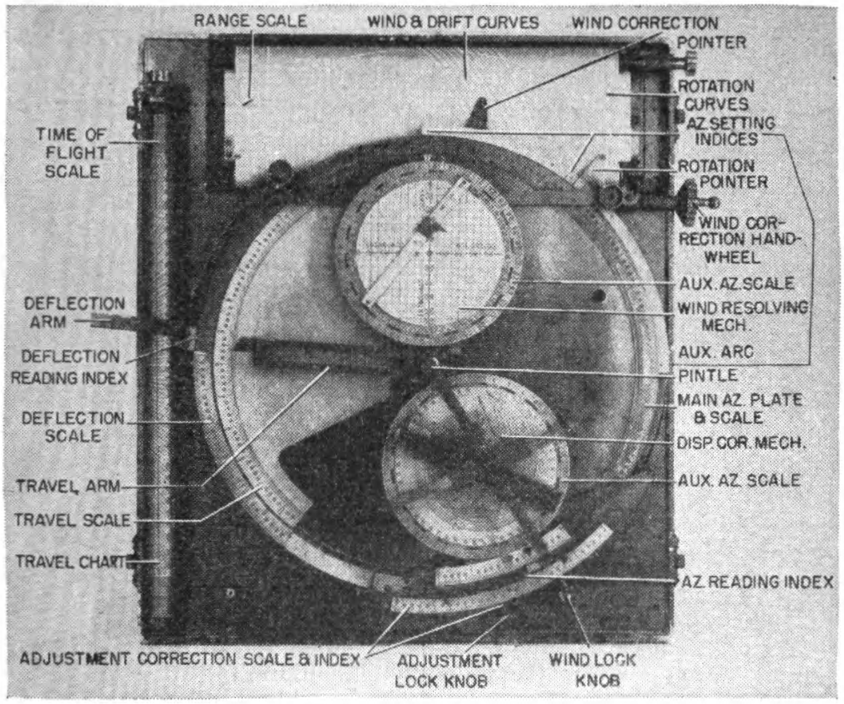


FIGURE 56.—Deflection board M1.

(1) Set the chart at the corrected range to the set-forward point.

(2) Release the adjustment lock knob and wind lock knob and bring the wind correction pointer to the normal curve (50) by means of the wind correction handwheel.

(3) Clamp both the adjustment lock knob and the wind lock knob.

(4) Bring the wind correction pointer to the wind curve indicated on the wind resolving mechanism by means of the wind correction handwheel. This last operation displaces the azimuth reading index by the amount of the correction.

Q. How is a correction for rotation of the earth set into the instrument? *A.*

(1) Set the ballistic correction chart at the corrected range to the set-forward point.

(2) Bring the rotation pointer to the proper azimuth curve on the chart. This pointer is fastened to the auxiliary arc bearing the setting index, so that in setting a rotation correction, the setting index is displaced by the amount of correction, and the main azimuth plate must be reset to the proper azimuth.

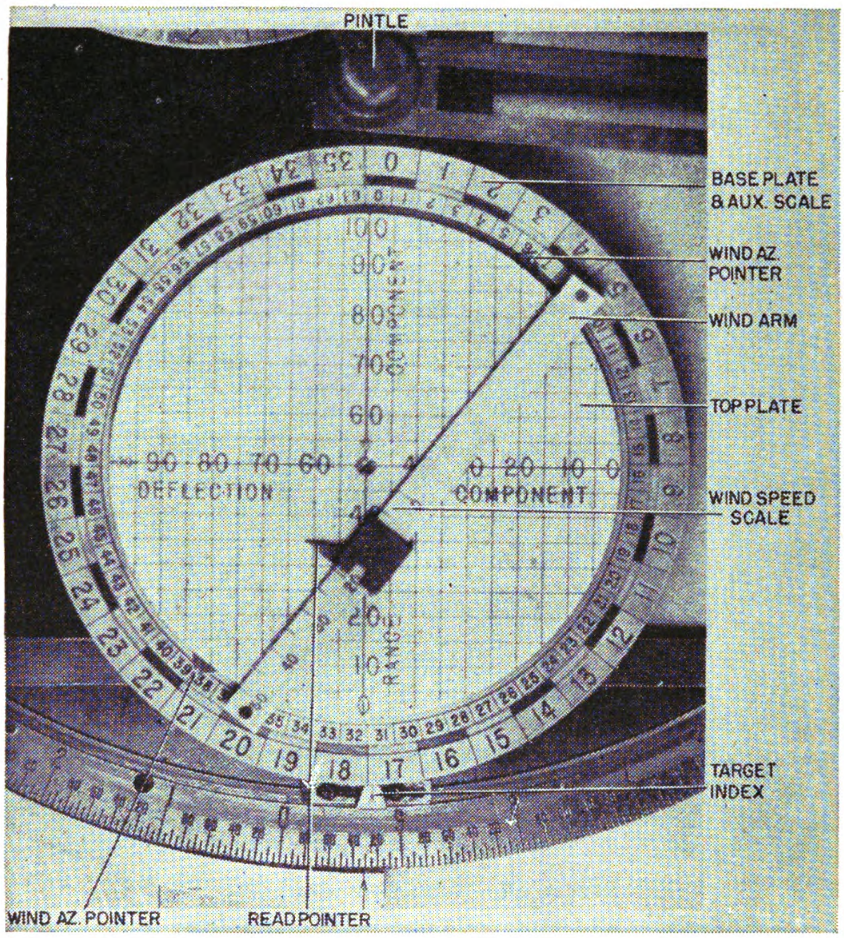


FIGURE 57.—Wind resolving mechanism on deflection board M1.

Q. Explain how to set in a lateral adjustment correction. *A*.

(1) Loosen the adjustment lock knob.

(2) Shift the reading index and the adjustment scale so that the desired correction is indicated opposite the adjustment correction index, and tighten the lock knob. The adjustment correction index remains locked to the wind correction pointer.

Q. Explain the purpose of the displacement corrector. *A*. The displacement corrector is for the purpose of correcting the firing data for parallax due to displacement; that is, if the guns are at a distance from the directing point sufficient to require the data, as

computed for the directing point, to be corrected for use on the guns, the displacement corrector applies the necessary lateral correction. Also, if the two guns of a battery are separated sufficiently to require different firing data, and one gun is designated the directing gun, the displacement corrector will apply a lateral correction to the firing azimuth for the other gun.

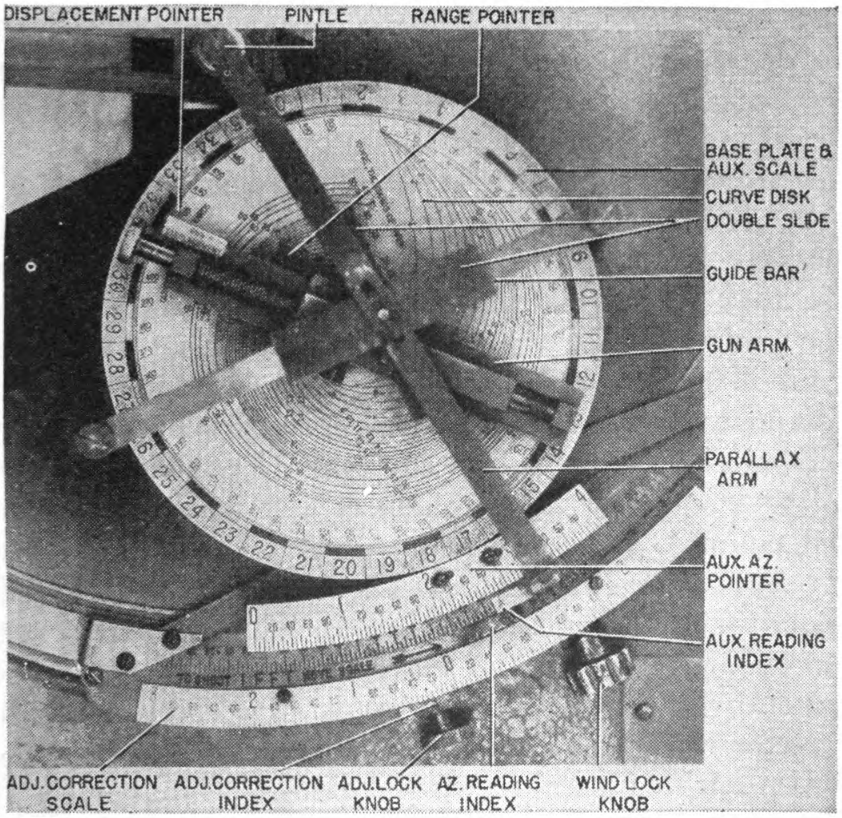


FIGURE 58.—Displacement corrector on deflection board M1.

Q. Explain how to set in a correction for displacement. *A.*

(1) Set the gun arm to the azimuth of the displaced gun from the directing point.

(2) Revolve the curve disk until the distance to the displaced gun, in yards, is set under the displacement pointer.

(3) Set the range pointer over the proper range curve on the curve disk.

(4) Read the corrected azimuth opposite the index on the parallax arm.

Q. What is the purpose of the angular travel computing mechanism? *A.* The angular travel computing mechanism is used in case II pointing for the purpose of correcting the deflection for the angular travel of the target during the time of flight.

Q. Explain its operation. *A*. After the main azimuth plate is set to the uncorrected azimuth to the set-forward point, set the travel arm to the normal (6.00) of the travel scale. When the next uncorrected azimuth is set, the travel arm, which is attached to the main azimuth plate by a slip friction device, will move with the main azimuth plate and indicate, on the travel scale, the angular travel of the target during the observing interval. The travel chart is rotated until the time of flight corresponding to the corrected range to the set-forward point is indicated opposite its index, and the deflection arm is set over the proper travel curve. The deflection is then read opposite the deflection reading index.

Q. How are ballistic and adjustment corrections applied for case II pointing? *A*. In the same manner as for case III pointing. The deflection scale is attached to the arm carrying the azimuth reading index, so that when that index is displaced, either by the wind correction pointer or for the purpose of adding an adjustment correction, the deflection scale is displaced by the same amount.

Q. How many men are required to operate this board? *A*. Two men are required for both case II and case III pointing. Operator A operates the wind resolving mechanism and the ballistic correction chart and pointers, and sets the uncorrected azimuths. Operator B wears a telephone head set connecting him with the azimuth setters or gun pointers at the guns. He operates the lateral adjustment correction mechanism and angular travel device and transmits the corrected azimuths or deflections to the guns. He operates the displacement corrector when that mechanism is used.

36. Azimuth adjustment slide rule.—*Q*. What is the purpose of the azimuth adjustment slide rule? *A*. To vary an angular adjustment correction according to the elevation in high angle fire.

Q. Who operates the azimuth adjustment slide rule? *A*. The deflection board operator.

Q. How is the azimuth adjustment slide rule operated? *A*. Assume that a mortar battery is firing in zone 8-A using base increment charges. The operator hears a correction ordered of "Left 0.15°" when firing at 55° elevation. He sets the 55° elevation mark opposite the 0.15° correction mark as shown in figure 59 and sets the runner over the mark representing zone 8-A, on the B. I. C. scale. He then applies the 0.15° correction on his deflection board. (When using this instrument, the adjustment scale on the deflection board should be marked in absolute values instead of reference numbers.) He observes the change in the correction as the elevation changes and keeps the correction set to the nearest 0.05°. Thus when the elevation

increases to 60° the operator should change the correction on the deflection board to 0.20°. When the zone changes, the upper disk is moved to bring the new zone marking under the runner. He then reads the new correction opposite the appropriate elevation on the elevation scale and applies it on the deflection board.

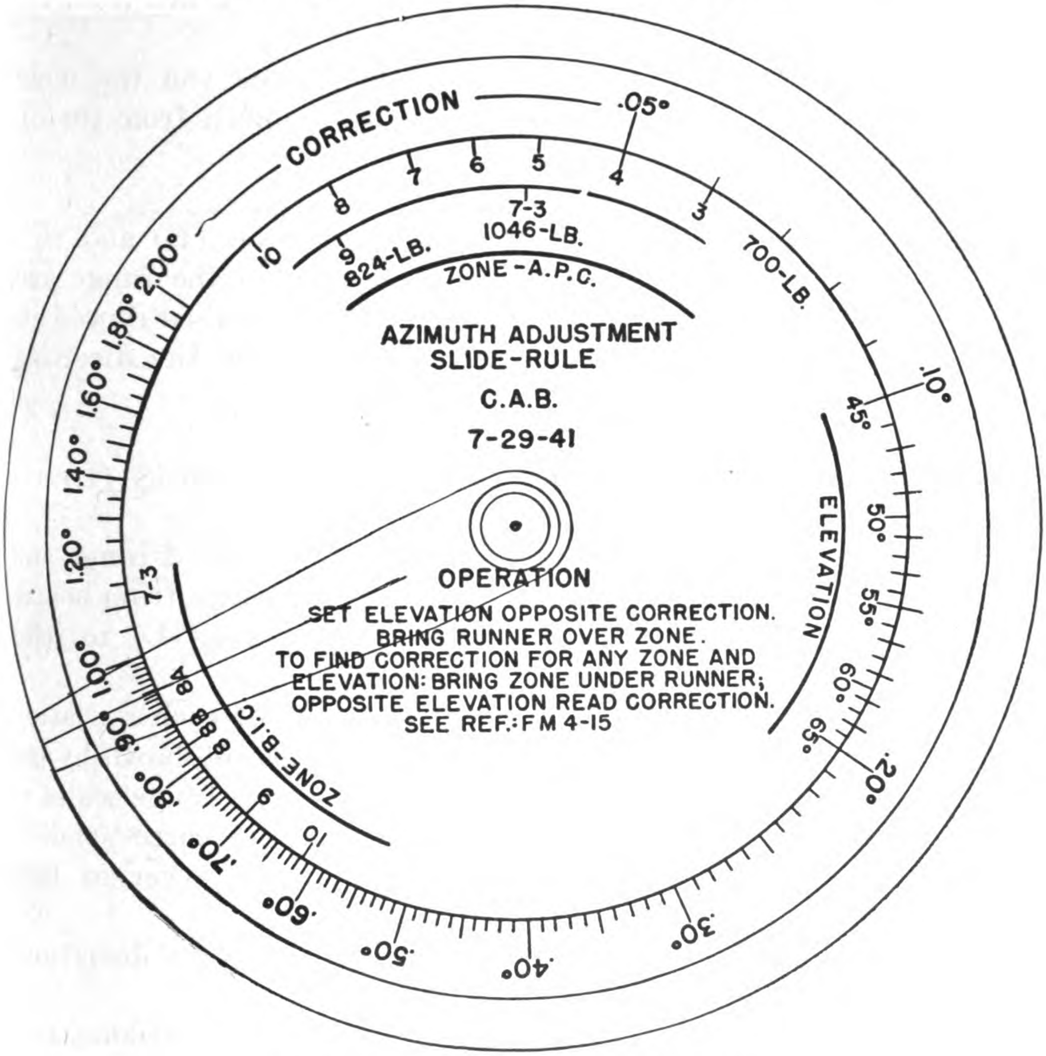


FIGURE 59.—Azimuth adjustment slide rule.

37. Spotting board M2.—*Q*. What is the purpose of the M2 spotting board? *A*. The M2 spotting board is the standard instrument for determining range and lateral deviations of shots from the target when bilateral terrestrial observation is available.

Q. How is the M2 spotting board oriented? *A*.

(1) See that the proper scales are inserted in the range scale (C) and the spotting platen (J), and that the proper sides of the deviation grid (B) and deviation disks (L) are up, depending on whether spotting is to be in percent of the range or in yards.

(2) Convert the distances from the directing point of the battery to each spotting station into inches at the scale of the board.

NOTE.—The graduations of the station arms are in inches.

(3) Loosen the clamp screws holding the station arms (G) in position and set each station to its proper distance in inches from the directing point.

(4) Turn each station arm until its index reads (on the inner azimuth circle of the orienting disk (D)) the azimuth from the directing point to that spotting station.

(5) Tighten the clamp screws.

(6) By turning the range and azimuth handwheels (E) and (F), the indexes of the orienting disk are made to read the range and azimuth of any target in the field of fire. The board then represents to scale in their proper relative positions the target, the directing point, and each spotting station.

Q. How is the spotting board M2 operated? *A.*

(1) See that the deviation grid (B) and deviation disks (L) are set so that each has its proper face up.

(2) Keep the orienting disk (D) set to the uncorrected range and azimuth to the set-forward point as determined on the plotting board.

(3) Set the range ring (P) on each deviation disk (L) to read the range from the directing point to the target.

(4) Set the range scale on the inner plate (O) of each deviation disk (L) to the range from that station to the target as shown by the reading of each station targ (H) on the spotting platen range scales.

(5) Set each deviation pointer (N) to the curve corresponding to the splash reading reported by the spotting observer at that station.

(6) On the deviation grid (B) read the range and lateral deviations indicated by the intersection of the deviation arms (M).

(7) Two operators are required, each connected by telephone to a spotting observer. One sets the uncorrected range to the set-forward point and operates the left-hand deviation disk. The other sets the uncorrected azimuth to the set-forward point, operates the right-hand deviation disk, and reads from the deviation grid the range and lateral deviations indicated by the intersection of the deviation arms (M).

38. Organization and duties of range section.—*a. General.*—*Q.* What is the range section? *A.* A group of battery personnel charged with the duty of range finding. It is under the command of the range officer and includes:

(1) Observing details.
(2) Spotting details.
(3) Plotting room detail.

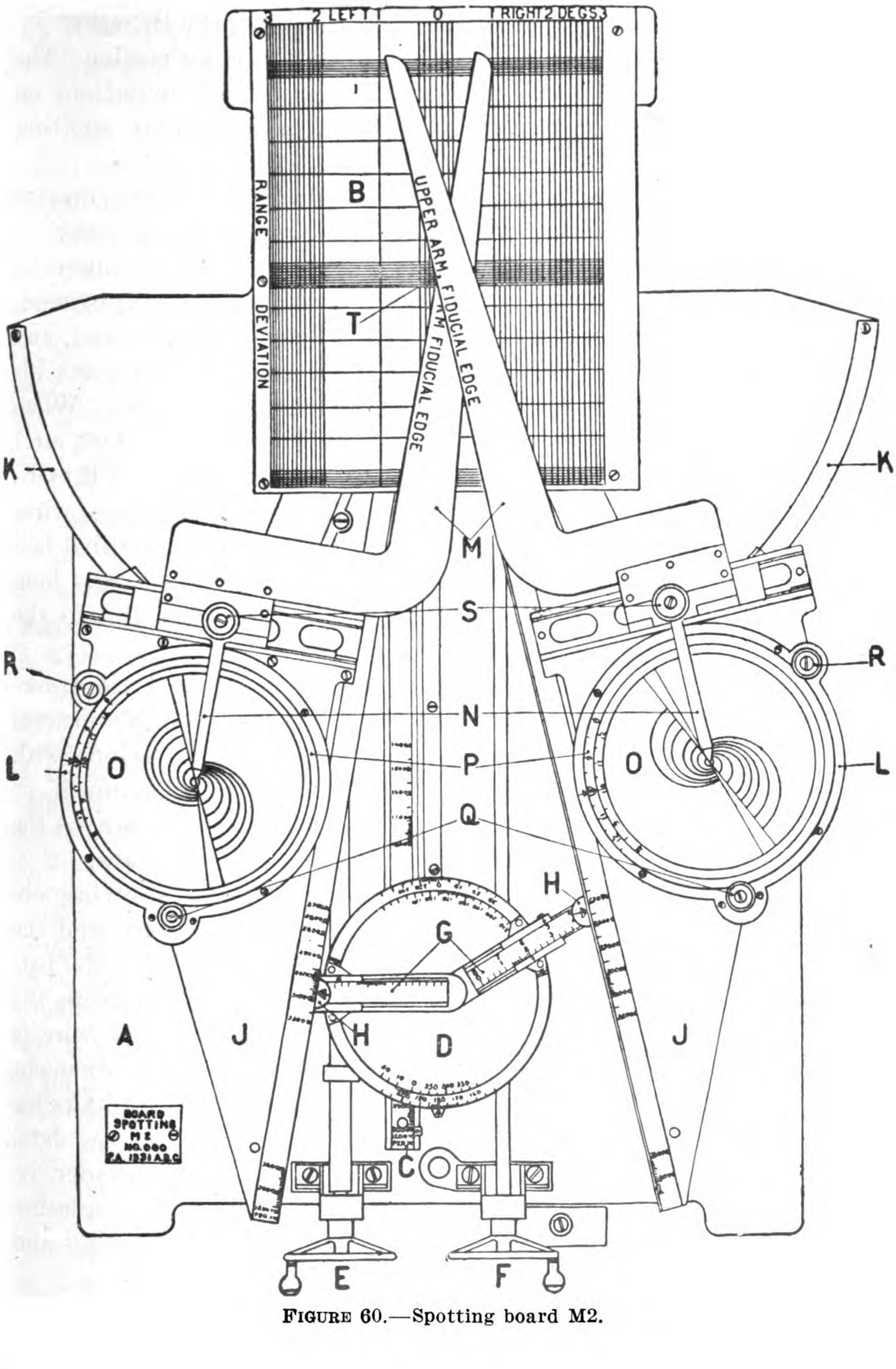


FIGURE 60.—Spotting board M2.

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Q. How are details of the section organized and assigned? *A*.

(1) Each observing detail consists of an observer and a reader, and is assigned to a particular observation station (B^1, B^2, etc).

(2) Each spotting detail consists of an observer and a reader. The reader may be omitted where the observer can read deviations on an internal scale. The detail is assigned to a particular spotting station (S^1, S^2, etc.).

(3) The plotting room detail varies according to the instruments in use. Its duty is to operate the apparatus in the plotting room.

b. Observing details.—*Q*. What are the duties of the observer, observing detail? *A*. He is responsible for the care, adjustment, and functioning of his instrument, the functioning of his detail, and the police of his station. On arrival at his station he inspects his instrument and reports its condition, as previously explained. When the target has been indicated and identified he reports, "B^1 (B^2, etc.) on target," and when the battery commander commands: TRACK, he alines his instrument with the target and keeps the cross wires accurately on the observing point of the target. When the third bell of the time-interval signal strikes, he stops following the target long enough to allow his reader to read the data and transmit to the plotting room.

Q. What are the duties of the reader and recorder? *A*. He functions under the direction of the observer and assists him in his general duties. On arrival at his station he tests the communications with the plotting room. When tracking starts he reads the azimuth, or azimuth and range, at each time-interval, transmits the data to the proper arm setter in the plotting room, and records the data.

c. Spotting detail.—*Q*. What are the duties of the spotting observer? *A*. He is responsible for his instrument, his detail, and the police of his station. He identifies the target and reports to the battery commander, "S^1 (S^2, etc.) on target." Thereafter he keeps the target alined with his instrument so that the vertical cross wire is accurately upon it. When a splash occurs he adjusts his instrument thereon and transmits the deviation to the plotting room, or halts his instrument long enough for his reader to read and transmit the data. If he is reporting deviations from the target and has no reader, he records his own data. In order that he may identify the splashes he should be informed from the battery of the instant of firing and the time of flight of the projectile.

Q. What are the duties of the spotting reader and recorder? *A*. They are similar to those of the recorder at an observation station.

d. Plotting room detail.—*Q.* Who is in charge of the plotting room detail? *A.* The range officer.

Q. What personnel are included in the plotting room detail when the Whistler-Hearn or 110° plotting board is used? *A.*

Plotter.
No. 1, angular travel device operator (case II) or gun arm azimuth reader (case III).
No. 2, primary arm setter.
No. 3, secondary arm setter.
No. 4, range correction board operator.
No. 5, set-forward device operator.
No. 6, percentage corrector operator.
No. 7, deflection board operator.
No. 8, assistant deflection board operator (note 1).
No. 9, fire adjustment board operator (an officer, if available).
No. 10, spotting board operator (note 2).
Nos. 11 and 12, assistant spotting board operators (note 2).
No. 13, data transmission device operator (note 3).
Nos. 14 and 15, recorders (note 4).

NOTES.—I. No. 8 is used only with the deflection board M1.

2. Where airplane observation of the fall of shots is provided, the use of the spotting board may become unnecessary. In such cases Nos. 10, 11, and 12 become unnecessary and may be eliminated. With some spotting boards only one assistant is necessary.

3. If the battery is not equipped with data transmission device, No. 13 will be eliminated. Where the data transmission system M5 is used, four operators are required.

4. Recorders in such numbers as are necessary to insure complete and accurate records for the purpose of drill and target practice analyses must be provided. Nos. 14 and 15 are provided as regularly assigned members of the plotting room detail. When they are not required for recording purposes they may be given other duties. Operators of instruments will record their own data when practicable.

Q. What personnel are included in the plotting room detail when the plotting and relocating board M1 or M1923 (Cloke) is used? *A.*

Plotter.
Platen operator.
No. 1, angular travel device operator (case II only). (Not needed when deflection board M1 is used.)
No. 2, plotting arm setter.
No. 3, relocating arm setter.
Nos. 4 to 15, inclusive (same as plotting room detail for Whistler-Hearn and 110° plotting board).

Q. What, in general, are the duties of all members of the range detail? *A*. After the details are posted each member examines, adjusts, and tests the particular apparatus which he operates, and reports to his chief of detail, "Sir, ——— in order," or any defects which cannot be corrected without delay. He is responsible for the proper functioning of the apparatus assigned to him.

At the close of drill or action the battery commander commands: BATTERY DISMISSED. The range officer commands: CLOSE STATIONS. Chiefs of detail supervise the replacement and securing of equipment and police of the stations.

Q. What are the duties of the plotter? *A*. He is chief of the plotting room detail, and responsible to the range officer for the equipment and personnel, and the police of the plotting room. He receives the reports from the observing and spotting details and from the various members of the plotting room detail, and reports to the range officer: "Sir, range section in order," or any defects that cannot be remedied without delay. He is responsible for the orientation, adjustment, and functioning of the plotting board. During drill, practice, or action, he plots on the board the observed positions of the targets and determines the set-forward points.

Q. What are the duties of the platen operator? *A*. He is required only when the plotting and relocating board is used. He assists in orienting the board and, during plotting, operates the platen.

Q. What are the duties of No. 1 (angular travel device or gun arm azimuth reader)? *A*.

(1) When the Whistler-Hearn board is used for case II pointing, he operates the tally dial and subdial, keeping them properly set, and calling out the angular travel at the proper times.

(2) For case III pointing he reads from the gun (or mortar) arm azimuth circle the uncorrected azimuth of the set-forward and predicted points.

(3) When the plotting and relocating board or the 110° board is used he operates the angular travel computer. Using data from the plotting board he determines from the angular travel computer the angular travel reference number for use on the deflection board.

(4) When deflection board M1 is used, and for case III pointing with the plotting and relocating board or the 110° board, No. 1 is eliminated.

Q. What are the duties of No. 2 (primary arm setter)? *A*. He wears a telephone head set on the line from the B^1 station and sets the B^1 arm at the azimuth received from the B^1 reader. If, when the vertical or self-contained base is used, the B^1 station is used to locate

the target, he also repeats the range received from the B^1 reader to the plotter; if the B^1 station is not used he has no duties. When the plotting and relocating board is used, he is the plotting arm setter, in which case he sets the plotting arm to the azimuth received from either the B^1 or the B^2 reader, depending on the set-up of the board.

Q. What are the duties of No. 3 (secondary arm setter)? *A*. He wears a telephone head set on the line from the B^2 station. His duties are, in general, similar to those of No. 2. When the plotting and relocating board is used he is the relocating arm setter. Except when using the Whistler-Hearn board he has the additional duties of operating the gun arm (or relocating arm), as directed by the plotter, in determining the range to the set-forward point, and of calling off the set-forward azimuth, when used.

Q. What are the duties of No. 4 (range correction board operator)? *A*. He operates the range correction board and transmits the ballistic range corrections to No. 6. Except when deflection board M1 is used he operates the wind component indicator.

Q. What are the duties of No. 5 (set-forward device operator)? *A*. He operates the set-forward ruler (or chart) and calls out the travel to the set-forward point to the plotter. When the predictor M1 is used No. 5 is eliminated. His duties are the same for all systems of position finding.

Q. What are the duties of No. 6 (percentage corrector operator)? *A*. He operates the percentage corrector. He is equipped with a telephone head set on the line to the guns.

Q. What are the duties of Nos. 7 and 8 (deflection board operator and assistant)? *A*. No. 7 assisted by No. 8 when necessary operates the deflection board and transmits deflections to the guns for case II pointing and azimuths for case III pointing.

Q. What are the duties of No. 9 (fire adjustment board operator)? *A*. He conducts the adjustment for range by use of the fire adjustment board or the over-short adjustment chart. This operator should be an officer or an enlisted man familiar with the mechanics of fire adjustment.

Q. What are the duties of Nos. 10, 11, and 12 (spotting board operator and assistants)? *A*. They determine the range and lateral deviations.

Q. What are the duties of No. 13 (data transmission device operator)? *A*. When data transmission devices are used he receives the corrected range or elevation and the deflection or corrected azimuth and sets them on his instrument. For zone fire he indicates the proper zone.

Q. What are the duties of Nos. 14 and 15 (recorders)? *A*. They keep the records necessary for analysis of drill and practice.

39. Battery commander's detail.—*Q*. What is the battery commander's detail? *A*. A group of personnel who assist the battery commander in the conduct of fire. The size of the detail depends upon the matériel in use. The detail is a part of the headquarters section.

Q. What personnel are included in the detail? *A*.

(1) *For gun and mortar batteries equipped with plotting rooms.*

(*a*) Battery commander's observer.

(*b*) Operator of the intelligence telephone.

(*c*) Operator of telephone to group command post.

(*d*) Operator of telephone to the guns.

(2) *For rapid fire batteries not equipped with plotting rooms.*—In this case corrections are usually made and applied in the battery commander's station, and the detail is thus a combined battery commander's detail and range section. It includes—

(*a*) Battery commander's observer (azimuth).

(*b*) Observer, self-contained range finder.

(*c*) Observer, spotting.

(*d*) Reader, battery commander's.

(*e*) Reader, self-contained range finder.

(*f*) Reader, spotting.

(*g*) Range correction ruler or range percentage corrector operator.

(*h*) Deflection board operator.

(*i*) Fire adjustment board (or over-short adjustment chart) operator.

(*j*) Transmission device or display board operator.

(*k*) Telephone operators.

(*l*) Recorder.

Q. What in general is the nature of the duties of the battery commander's detail? *A*. Where there is a range section they make such observations as may be directed by the battery commander for the purpose of enabling him to keep a check on the accuracy of the work of the range section and to conduct fire efficiently. For rapid fire batteries their duties are similar to those of a range section, with such modifications as the different equipment makes necessary.

CHAPTER 5

USE, ORIENTATION, AND ADJUSTMENT OF OBSERVATION INSTRUMENTS

40. Azimuth instruments.—*Q*. For what purpose is an azimuth instrument used? *A*.

(1) To measure the azimuth (direction) to any point such as a target, and

(2) To measure the angular deviation of a splash from the target.

Q. Name the three main parts of an azimuth instrument and state their uses. *A*.

(1) The telescope, which contains the lenses that enable the observer to see distant objects.

(2) The base, which supports the telescope and provides gears for traversing and scales for reading the azimuths.

(3) The tripod, which supports the base.

Q. Is a tripod always used? *A*. No; in permanent stations a "pier mount" is usually provided. It consists of a tripod head mounted in concrete or steel.

Q. Where are azimuth instruments generally used? *A*. In base end stations and spotting stations.

Q. How many men are necessary to operate the instrument? *A*. When determining azimuths, two are required, an observer and a reader; when measuring deviations (spotting), one man does both jobs.

Q. How are azimuths measured? *A*. The observer tracks the target keeping the vertical cross wire accurately on the designated point of the target until a signal is sounded indicating the end of an observing interval. At this instant he stops traversing the instrument and the reader reads the azimuth. This process is repeated throughout the course.

Q. How are deviations measured? *A*. The observer keeps the cross wire on the target until the splash occurs. The instrument is then held stationary and the angular deviation of the splash is read directly (without using the splash pointer) by means of the deflecting scale etched on the reticle. If it is desired to read the deviation of the center of impact of a salvo, the splash pointer is moved to the esti-

mated position of the center of impact and the deviation is read on the deflection scale.

Q. What are the necessary adjustments for reading azimuths? *A.* (1) Exact location of the instrument over the point representing the base end station.

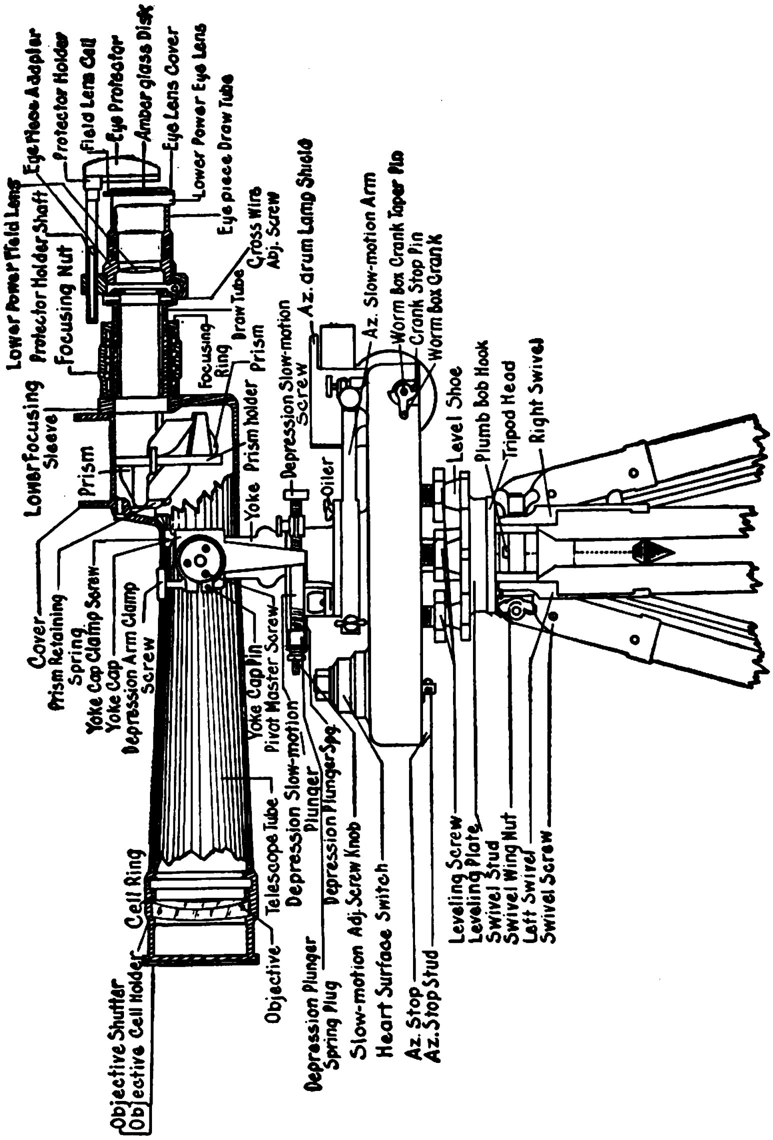


FIGURE 61.—Azimuth instrument M1910A1.

(2) Leveling of instrument.
(3) Focusing of eyepiece.
(4) Removal of parallax.
(5) Orientation to read correct azimuths.

Q. What are the necessary adjustments for reading deviations? *A.*
(1) Leveling of instrument.
(2) Focusing of eyepiece.
(3) Removal of parallax.

Q. Describe the adjustment of an azimuth instrument for reading azimuths. *A*.

(1) *Exact location.*—Set up and adjust the height of tripod as desired, mount the base on the tripod head, and hang a plumb-bob from the base. With the aid of the plumb-bob the tripod and base approximately over the point representing the base end station, making the tripod head as nearly level as possible by eye. Mount and secure telescope in place on the yoke. Traverse the instrument until it reads the azimuth of a known datum point visible from the station. Loosen the azimuth clamp and turn the telescope so that it is in its normal position on the base with the eyepiece extending over the rear of the base. Lift up the instrument and tripod together and set them down so that the telescope points in the general direction of the datum point. Center the plumb-bob over the point representing the station by shifting the tripod legs, keeping the tripod head as nearly level as possible and the telescope pointed approximately at the datum point. Make sure that the legs when finally adjusted are firmly fixed into the ground.

NOTE.—When using a pier mount this operation is greatly simplified because the exact location is already provided.

(2) *Leveling.*—See that all four leveling screws have a uniform and moderately firm bearing on the leveling plate. Release the traversing worm by rotating the worm box crank, and traverse the instrument until one of the levels on the base is parallel to two diagonally opposite leveling screws. Turn those screws simultaneously, one clockwise and the other counterclockwise, until the level bubble is centered. The bubble will follow the motion of the left thumb. Without traversing the instrument center the bubble of the other level by means of the other two leveling screws, readjusting each bubble for any error caused in centering the other. Traverse the instrument 180° and check the level; if a bubble leaves the center, correct one-half of the error by the adjusting screws on the level box and the other half by the proper pair of leveling screws. Repeat the operation until the level bubbles remain centered for any position of the telescope.

(3) *Focusing eyepiece.*—Screw the eyepiece in or out until the roughness of the cross wires can be seen most distinctly. This should be done with the telescope pointed at the sky, if possible.

(4) *Removal of parallax.*—Parallax is the apparent motion of the cross wire across the image of an object as the eye is moved from side to side across the eyepiece. It is caused by improper focusing of

the objective lens. To remove parallax, point the telescope at a distant object and move objective lens in or out by means of the focusing ring, until the cross wire remains on the same point of the image as the eye is moved.

NOTE.—This operation is unnecessary on some types of instruments because they have a fixed focus.

(5) *Orientation.*—After all other adjustments have been made, reset the instrument to read the azimuth of the datum point, loosen the azimuth clamp screw, and bring the vertical cross wire on or very nearly on the datum point. Tighten the azimuth clamp screw and bring the vertical cross wire exactly on the datum point by means of the azimuth slow motion screw. Clamp the azimuth slow motion screw. Check the adjustment by traversing the instrument away from and back to the datum point several times, checking the readings of the azimuth scale. The orientation should be checked on at least one other known datum point.

Q. What precautions should be taken in leveling? *A.* Have each leveling screw bear firmly but not too tightly on the leveling plate; do not force a screw if it binds, but slack off on the opposite screw. Binding of the screws will bend the spindle and make correct leveling of the instrument impossible in the future.

Q. What two standard types of azimuth instrument are issued? *A.* The azimuth instrument M1910A1 and M1918.

Q. What are the main differences between them? *A.* The M1910A1 instrument is graduated in degrees and hundredths and cannot be used to measure vertical angles; the M1918 instrument is graduated in mils and can be used to measure vertical angles from minus 300 mils to plus 500 mils.

Q. How should azimuth instruments be stored when not in use? *A.* In the case provided for them.

Q. How should azimuth instruments be cared for? *A.* No adjustment of the interior lenses should be attempted except by ordnance personnel. One eyepiece should always be kept assembled in the telescope to prevent dust or moisture from collecting on the reticle. The other eyepiece should be kept in the pocket in the carrying case. A camel's-hair is provided for removal of dust from the reticle and lenses. Soft tissues, silk, and cambric also may be used on the lenses.

41. Depression position finders.—*Q.* For what purpose is a D. P. F. used? *A.* To measure both range and azimuth. It indicates the range on a drum or disk which moves in proportion to the angle the telescope is depressed from the horizontal to the water line of the target.

Q. What adjustments are required on a D. P. F.? *A.*

(1) Leveling.
(2) Focusing eyepiece.
(3) Removal of parallax.
(4) Orientation to read correct azimuths.
(5) Range adjustment to correct for tide, curvature, and refraction.

Note.—On the Swasey D. P. F. the adjustment for "telescope level" is also necessary. This consists of moving the range drum to indicate "telescope level" when the telescope is horizontal.

Q Describe the adjustments. *A.* All except the range adjustment are similar to those for an azimuth instrument. The range adjustment is as follows:

(1) Set off on the height scale the height of instrument (corrected for tide, if tide is known).

(2) Select two datum points, D_L at a range somewhat longer, and D_S at a range somewhat shorter than the ranges over which it is expected to work.

(3) Set the range drum by normal operation at the range to D_L and traverse the instrument on that point. Bring the horizontal cross wire onto the water line by means of the micrometer screw (Swasey) or the compensating screw (M1907 and M1).

(4) Set the range drum by normal operation at the range to D_S and traverse the instrument on D_S. Waterline by changing the height setting by means of the height slide pinion (Swasey) or the adjusting screw (M1917 and M1).

(5) Repeat operations (3) and (4) until correct range readings can be obtained on both D_L and D_S by normal operation.

Q. Is one range adjustment sufficient? *A.* No; it should be repeated every 15 or 30 minutes while the instrument is in use.

42. Self-contained horizontal base range finders.—*Q.* For what purpose are self-contained horizontal base range finders used? *A.* They are used with rapid-fire batteries and for emergency range finding with larger caliber guns.

Q. What different types of self-contained horizontal base range finders are in use? *A.*

(1) Stereoscopic type.
(2) Coincidence type.

Q. What is the adopted standard for seacoast artillery? *A.* The stereoscopic height finder M1 originally designed for antiaircraft artillery.

Q. What is meant by a stereoscopic range finder? *A*. An instrument which gives correct ranges when the object sighted appears at the same distance, or depth, as an image or reticle, marked on a lens of the optical system.

Q. What adjustments are necessary when using the stereoscopic range finder? *A*.

(1) Leveling of instrument.
(2) Orientation of instrument.
(3) Collimation of trackers' telescopes.
(4) Setting of interpupillary distance.
(5) Selection of magnifying power.
(6) Selection of ray filter.
(7) Focusing of eyepieces.
(8) Adjustment of head rest.
(9) Height of image adjustment.
(10) Determination and application of range corrector setting.
(11) Setting of range height lever.

Q. How many operators are required for the range finder M1 and what are they? *A*. Four: elevation tracker, azimuth tracker, observer, and reader.

Q. What is meant by a coincidence range finder? *A*. An instrument which gives correct ranges when the object sighted appears unbroken in both the upper and lower part of the eyepiece.

Q. What adjustments are necessary when using a coincidence range finder? *A*.

(1) Leveling.
(2) Orientation (when equipped to read azimuths).
(3) Focusing of eyepiece.
(4) Halving adjustment.
(5) Range (coincidence) adjustment.

Adjustments (1) and (2) are the same as for any other observation instruments.

Q. Describe the halving adjustment. *A*. Sight on an object such as a flag pole or spire; move the telescope in elevation until the object is seen only in the lower field; then gradually change the elevation until the image rises to the separating line. If halving is correct, the top of the object will appear above the dividing line at the instant it disappears from the lower field. If the image appears too soon, rotate the halving adjusting knob *upward*. If the image appears too late, rotate the halving adjustment knob *downward*.

Q. Describe the range (coincidence) adjustment. *A*. Turn the measuring knob until the scale reads the range to a known object. If

the partial images do not coincide, move the correction wedge dial until the partial images coincide (come together). Check at two or more known ranges, and then leave adjustment alone.

Q. When is the astigmatizer used? *A.* At night when observing on small lights.

Q. Describe briefly the operation of the instrument. *A.* The observer and trainer bring the instrument approximately on the target by sighting over it. Thereafter the trainer keeps the instrument on the target and the observer brings the two partial images into coincidence. When coincidence is obtained (not necessarily at any given time-interval, the range is read from the range scale.

CHAPTER 6

POINTING METHODS AND INSTRUMENTS

43. Pointing methods.—*Q*. What is meant by pointing? *A*. The operation of giving a piece a designated elevation and direction.

Q. What two general methods are used to point a gun in direction? *A*. The direct and the indirect method.

Q. How is a gun pointed in direction by the direct method? *A*. The sight is pointed directly at the target and the axis of the bore is caused to diverge from the line of sight by an angular amount called the "deflection."

Q. How is a gun pointed in direction by the indirect method? *A*. The axis of the bore is pointed in azimuth.

Q. What two methods are used to point the gun in azimuth? *A*.

(1) By means of a panoramic telescope and a fixed aiming point other than the target.

(2) By means of an azimuth circle or dial.

Q. What two general methods are used to point in elevation? *A*. The method which uses "quadrant elevation" and the method which uses "angle of elevation."

Q. How is a gun pointed by quadrant elevation? *A*. By the use of a device which sets off the elevation of the gun from horizontal.

Q. How is a gun pointed by angle of elevation? *A*. By waterlining the target with a sight and elevating the gun above the line of sight an amount sufficient to correct for the curvature of the trajectory.

Q. According to the combinations of pointing methods used, how many cases of pointing are there for seacoast artillery? *A*. Three.

Q. Name the three cases of pointing. *A*. Case I, case II, and case III.

Q. What is case I pointing? *A*. Pointing in which direction and elevation are imparted to the gun by means of the sight. Data are applied to the piece in the form of settings of deflection and angle of elevation.

Q. What is case II pointing? *A*. Pointing in which direction is imparted to the gun by means of the sight, and elevation is imparted by means of an elevation scale or graduated range drum. Data are applied to the piece in the form of settings of deflection and quadrant elevation, the latter being given in terms of range when a range drum is employed.

Q. What is case III pointing? *A*. Pointing in which direction is imparted to the piece by means of an azimuth circle, a "match the pointer" indicator, or a sight pointed at an aiming point other than the target, and elevation is imparted to the piece by means of an elevation quadrant, a range disk, or a "match the pointer" indicator. Data are applied to the piece in the form of settings of firing azimuth and quadrant elevation, the latter being given in terms of range when a range disk is employed.

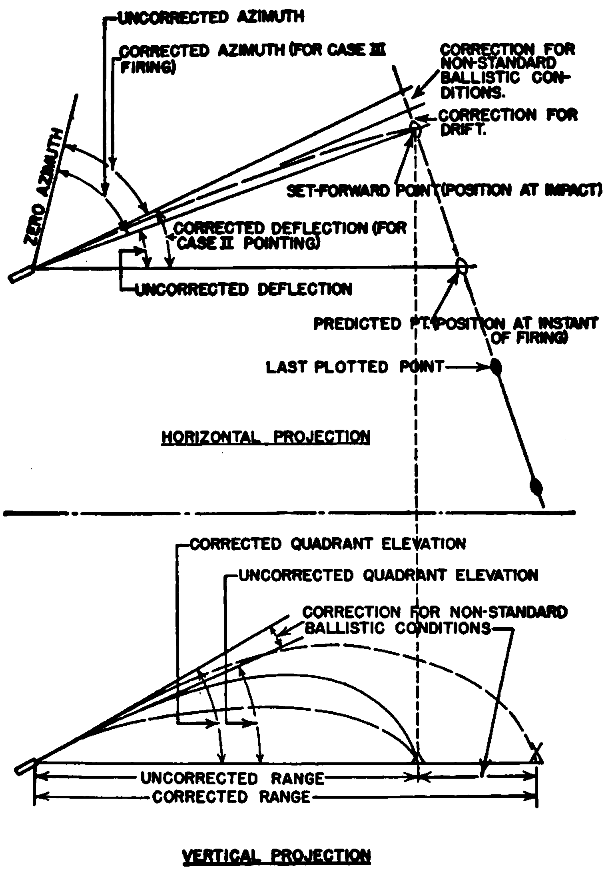


FIGURE 62.—Elements of corrected firing data.

NOTE.—For illustration of elements of uncorrected firing data see figure 44.

Q. What method (or methods) of pointing is (are) used for the guns or mortars in your batter? *A*. ———.

Q. What is the rule for pointing in direction to which all seacoast artillery pointing equipment conforms? *A*. RIGHT, RAISE; LEFT, LOWER.

Q. What does the rule "RIGHT, RAISE; LEFT, LOWER," mean? *A*. If the deflection (or azimuth) is increased, the gun will be pointed farther to the right; if the deflection (or azimuth) is decreased, the gun will be pointed farther to the left.

Q. What fixed seacoast gun is sometimes fired by case I? *A.* The 3-inch rapid-fire gun.

44. Pointing instruments.—*Q.* What instrument for pointing the piece in direction by case II is provided for all fixed seacoast artillery cannon except the 12-inch mortar? *A.* Telescope (formerly called telescopic sight).

Q. Set a deflection of —— and point the gun. *A.* (Practical demonstration.)

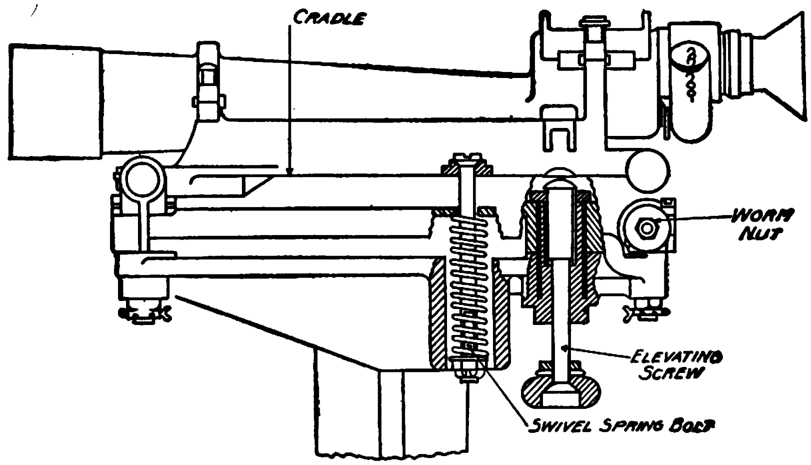


FIGURE 63.—Telescope M1912 and mount.

Q. What device for pointing the piece in direction by case III is provided for all fixed seacoast cannon? *A.* Azimuth circle.

Q. Set an azimuth of —— by means of the azimuth circle. *A.* (Practical demonstration.)

Q. What instrument for pointing in elevation is used on most fixed seacoast cannon? *A.* Range disk.

Q. How is the gun pointed in elevation by range disk? *A.* Elevate the gun until the desired range setting on the range disk is opposite the index.

Q. Set a range of —— yards on the range disk. *A.* (Practical demonstration.)

Q. On what fixed seacoast cannon is the elevation quadrant M1908 or M1906 used for pointing the piece in elevation? *A.* 12-inch mortars.

Q. How is the mortar pointed in elevation? *A.* Set off the proper elevation on the quadrant and elevate the mortar until the level bubble is centered.

Q. Set a quadrant elevation of —— on the elevation quadrant. *A.* (Practical demonstration.)

Q. On what type of fixed seacoast cannot other than mortars may elevation quadrants be used? *A.* Modern type barbette carriages.

Q. What instruments are used to point the guns (or mortars) assigned to your battery? *A*. ———.

Q. What is a gunner's quadrant? *A*. An angle-measuring device used for checking the elevation of a gun or for pointing a gun in elevation.

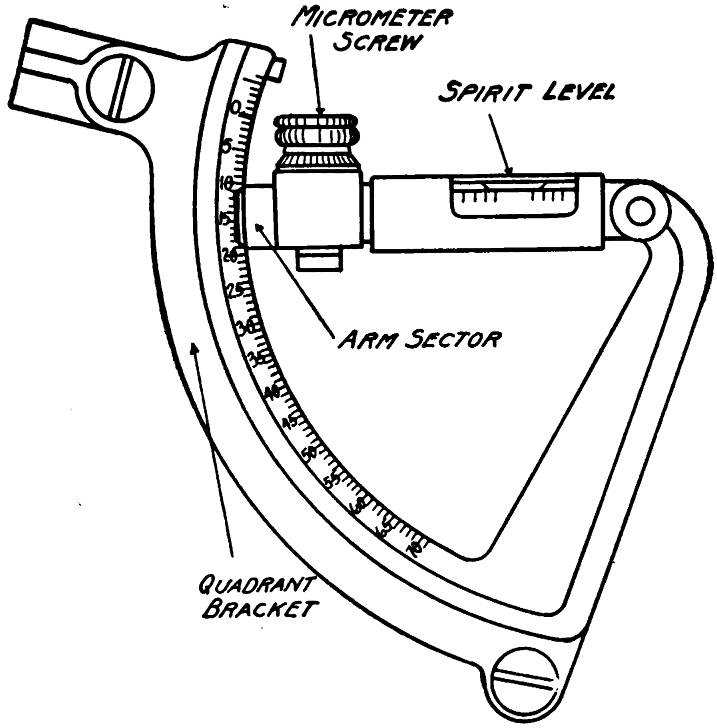


FIGURE 64.—Elevation quadrant M1908.

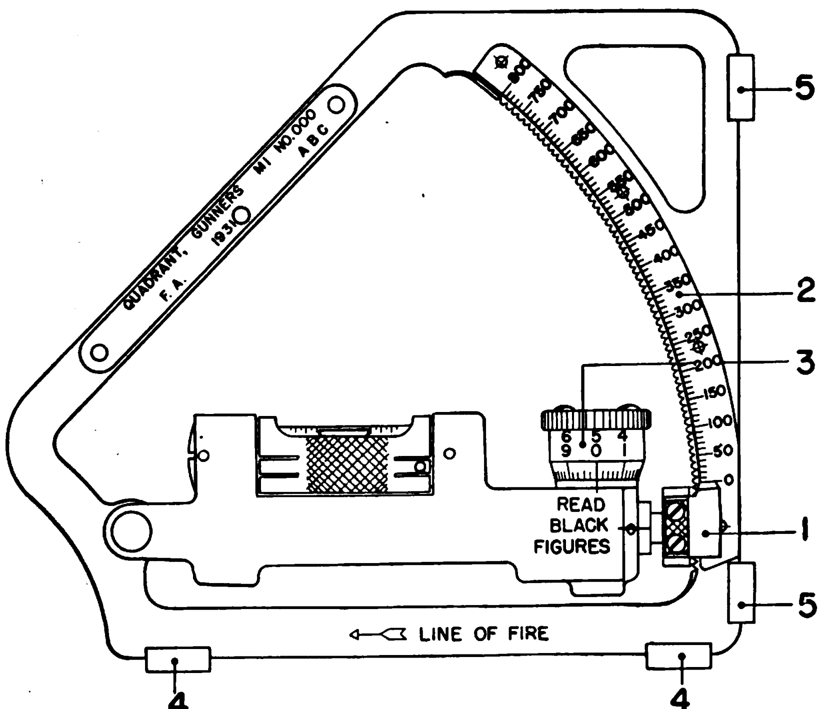


FIGURE 65.—Gunner's quadrant M1.

Chapter 7

AMMUNITION

Section I

POWDERS, PROJECTILES, PRIMERS, AND FUZES

45. Powders.—*Q*. What kind of powder is used in cannon as a propelling charge? *A*. Smokeless, nitrocellulose.

Q. What is the form of its grains? *A*. Perforated cylinders.

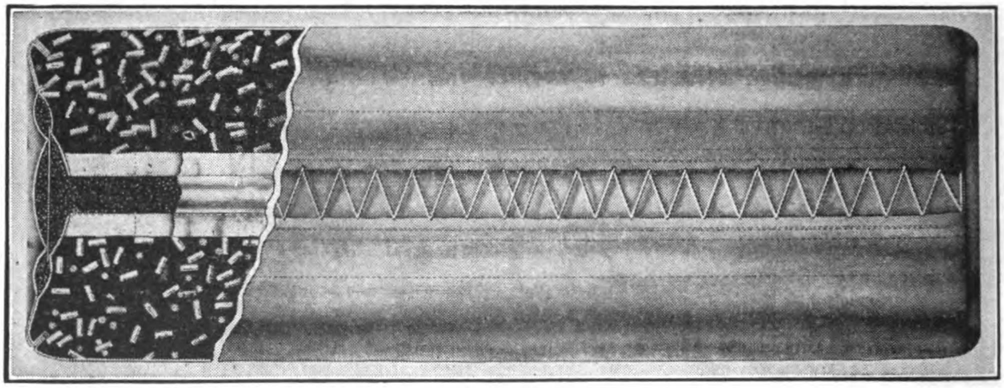


Figure 66.—Single-section propelling charge.

Q. What is the weight of the service charge for a gun of the model and caliber in your battery? *A*. —— pounds. (See ammunition chart at end of this section.)

Q. What is the purpose of the igniting charge? *A*. To secure quicker ignition of the smokeless powder.

Q. Where is the igniting charge located? *A*. It is quilted in the rear end of each charge.

Q. What kind of powder is used as the igniting charge? *A*. Black powder.

Q. How is powder stored? *A*. In airtight cases in magazines.

Q. What is the normal muzzle velocity of the gun of the model in your battery, with service charge? *A*. —— foot seconds.

Q. What materials are used in the manufacture of powder bags? Why? *A*. Powder bags usually are made of special raw silk which burns without leaving any residue. (A special cotton cloth has been found suitable as a substitute material.) A spark remaining in the bore after firing might ignite the products of combustion when the breech is opened, thus causing a form of explosion known as a flare-back.

Q. Should powder be stored in the same magazine with fuzes and primers? *A*. No. Powder and projectiles must be stored separately from primers and fuzes. However, primers and fuzes may be stored together.

Q. Are powder charges always made up in bags? *A*. No. Separate-loading ammunition has the powder in bags but in fixed ammunition the powder is in the brass cartridge case.

Q. Should you have a lighted match or a cigarette around powder? *A*. No.

Q. What is meant by the term "stacked charge"? *A*. The term "stacked charge" is applied to powder charges which have been especially prepared at the arsenal. The powder grains lie end to end within the powder bag.

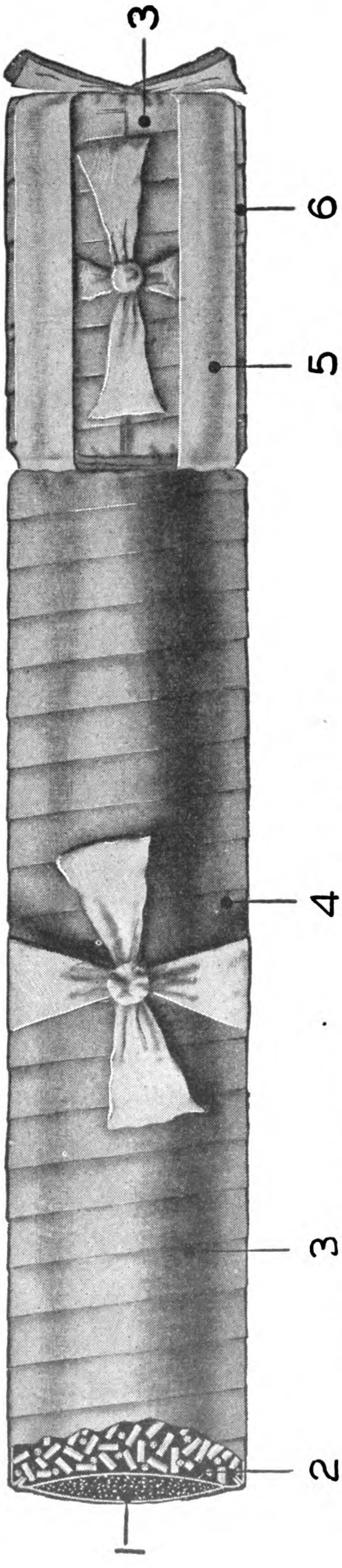
Q. What types of armament use stacked charges? A. Major caliber armament, 12-inch and above.

46. Projectiles.—*Q*. Name and point out the principal parts of a projectile. *A*. Base, body, bourrelet, cap, cavity, ogive, point, and rotating band.

Q. What is the purpose of the bourrelet? *A*. To provide a smooth bearing surface for centering the forward part of the projectile in the bore. It is a carefully machined and finished surface and is of slightly less diameter than the bore of the gun, but greater than the body of the projectile.

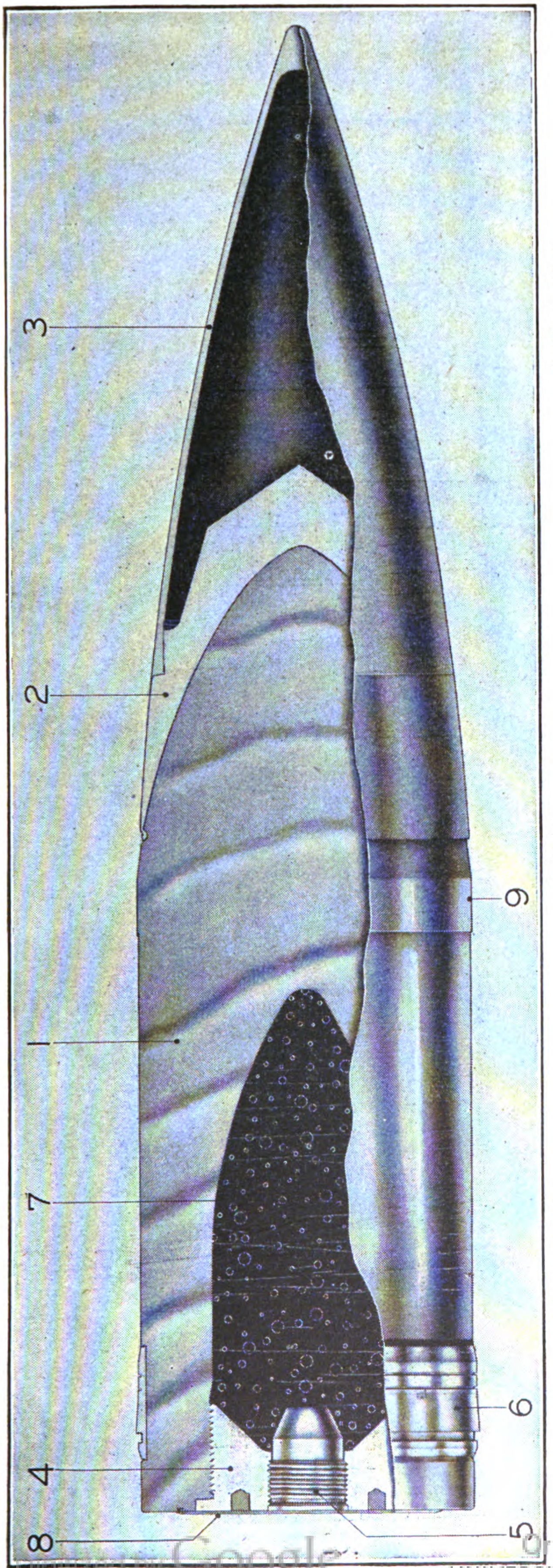
Q. What parts of the projectile bear against the lands of the bore? *A*. The bourrelet and the rotating band.

Q. Describe the rotating band and state its purpose. *A*. The rotating band is a cylindrical ring of copper or gilding metal, pressed into a groove near the base of the projectile. The diameter of the rotating band is somewhat greater than the diameter of the bore between the lands. When the gun is fired, the rotating band engages with the



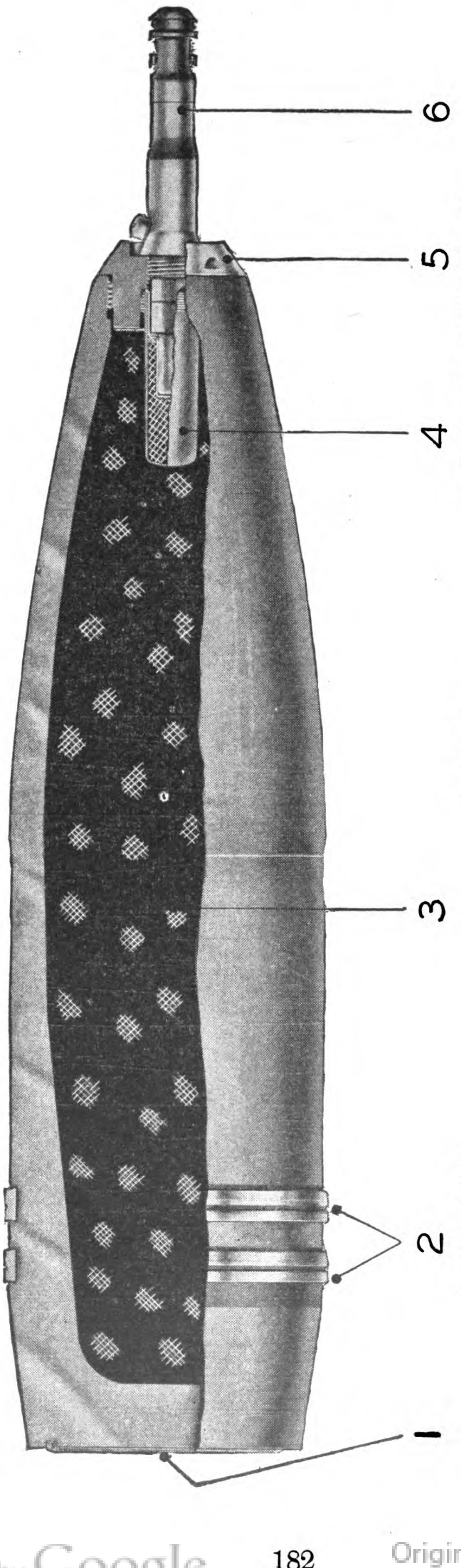
1. Igniter (black powder).
2. Smokeless powder.
3. Spiral wrapping.
4. Base section.
5. Tying straps.
6. Increment section.

FIGURE 67.—155-mm gun propelling charge (base and increment type).



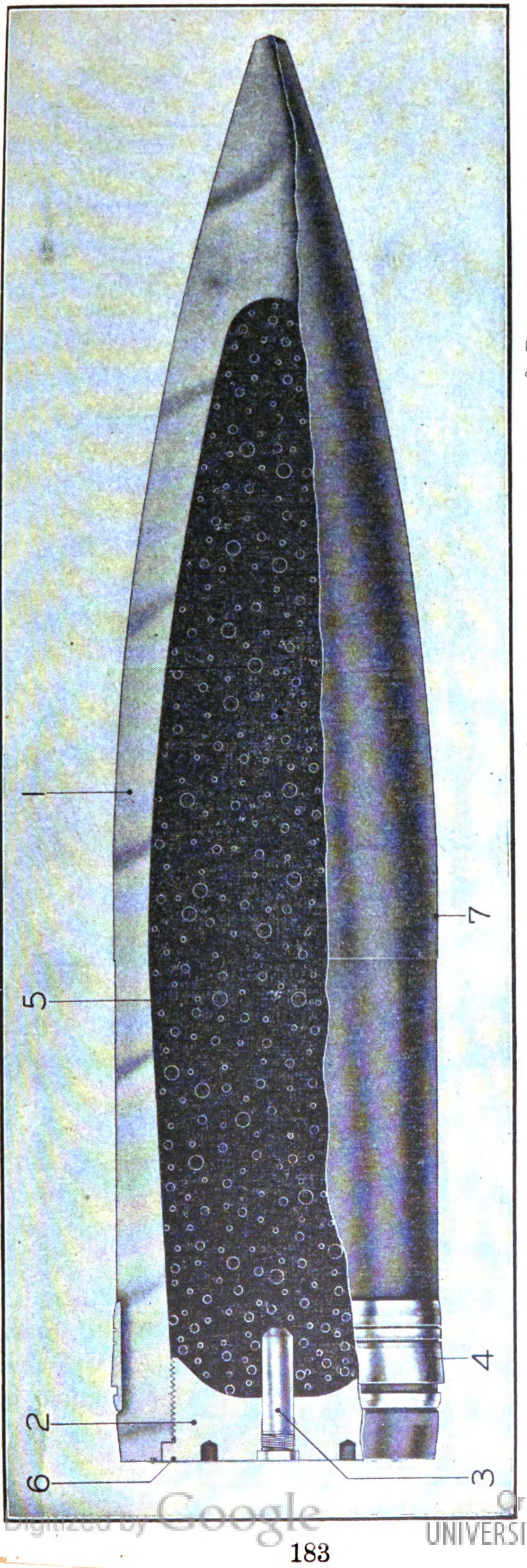
1. Steel shell.
2. Armor-piercing cap.
3. Windshield.
4. Base plug.
5. Fuze.
6. Rotating band.
7. Bursting charge (explosive D).
8. Base cover.
9. Bourrelet.

FIGURE 68.—Armor-piercing projectile.



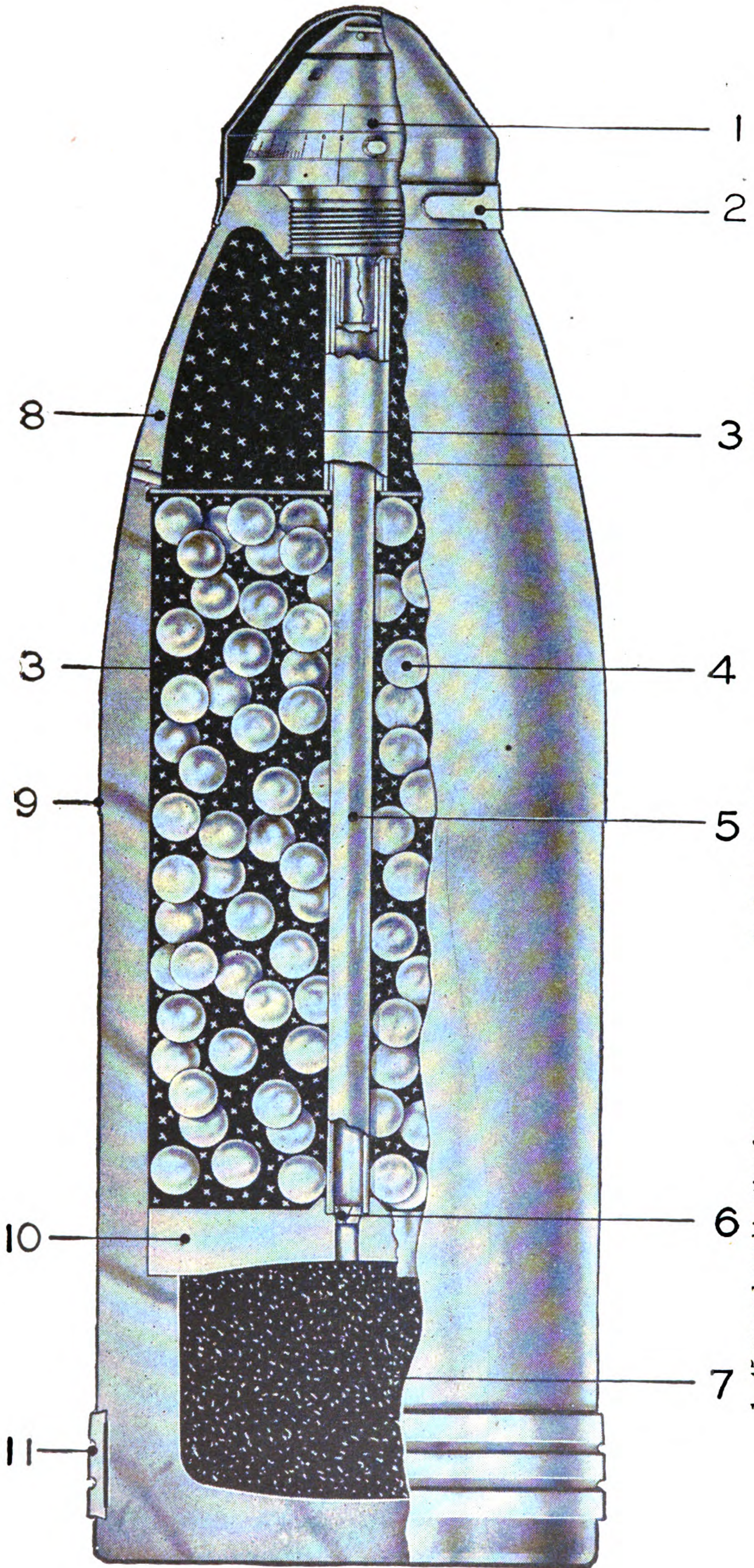
1. Base cover.
2. Rotating bands.
3. Bursting charge (TNT or amatol).
4. Booster.
5. Adapter.
6. Fuze (to be inserted at battery).

FIGURE 69.—155-mm high explosive shell Mk. III.



1. Steel shell.
2. Base plug.
3. Fuze.
4. Rotating band.
5. Bursting charge (explosive D).
6. Base cover.
7. Bourrelet.

FIGURE 70.—High-explosive shell.



1. 45-second combination fuze M1907.
2. Tear-off strip or soldering-strip of waterproof cover.
3. Matrix (resin).
4. Balls.
5. Central tube.
6. Fiber paper cup and cloth disk.
7. Base charge (loose black powder).
8. Head.
9. Bourrelet on shrapnel case.
10. Diaphragm.
11. Rotating band.

FIGURE 71.—155-mm shrapnel Mk. I.

rifling in the bore and thus centers the projectile in the bore, prevents the escape of gas past the projectile, and imparts a motion of rotation to the projectile.

Q. What projectiles are furnished for artillery? *A*. Armor-piercing projectiles, high-explosives (common steel) projectiles, target-practice projectiles, dummy projectiles, and subcaliber projectiles. (Armor-piercing and deck-piercing shot and shell have been declared obsolete for future manufacture and will ultimately be replaced by armor-piercing projectiles for cannon of 12-inch or greater caliber and by common steel shell for cannon of smaller caliber.)

Q. For what purposes are common steel shell used? *A*. Usually to attack unarmored or lightly armored parts of warships.

Q. What is a bursting charge? *A*. A quantity of explosive placed in a projectile in order to burst it on impact or at a given time.

Q. What explosive is used as a bursting charge for high-explosive projectiles? *A*. Trinitrotoluol (TNT). Some shells are loaded with amatol.

Q. What explosive is used as a bursting charge for armor-piercing projectiles? *A*. Usually explosive D.

Q. Why are projectiles painted? *A*. To prevent rust and to furnish a means of identification.

Q. What are the weights of the projectiles for the guns of your battery? *A*. —— pounds. (See ammunition chart at end of this section.)

Q. What color are projectiles painted that are filled with high explosive? *A*. Yellow.

Q. How should projectiles be handled? *A*. With care. Take particular care not to injure the rotating band.

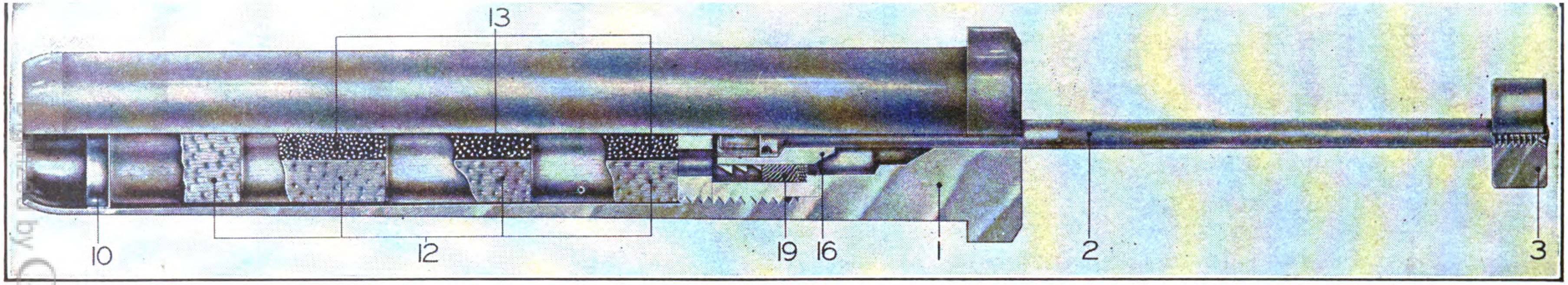
47. **Primers.**—*Q*. What is a primer? *A*. A primer is a device used to ignite the propelling charge in the gun.

Q. Name the classes of primers. *A*.

(1) Drill.
(2) Friction.
(3) Electric.
(4) Percussion.
(5) Combination percussion-electric.
(6) Igniting.

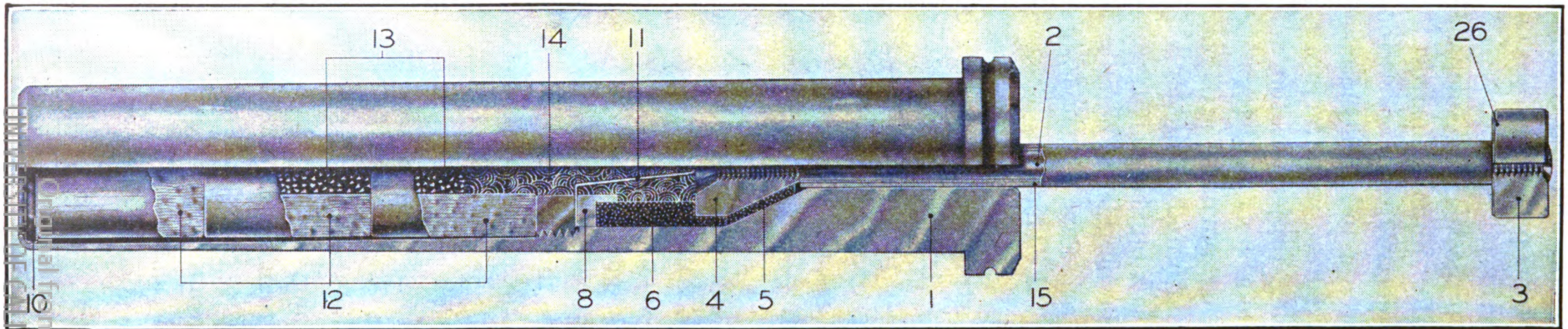
Q. What primers do you use at your battery? *A*. See ammunition chart at end of this section.

Q. Why are drill primers furnished in addition to electric primers and friction primers M1914? *A*. The drill primer is much cheaper and can be loaded at the post.



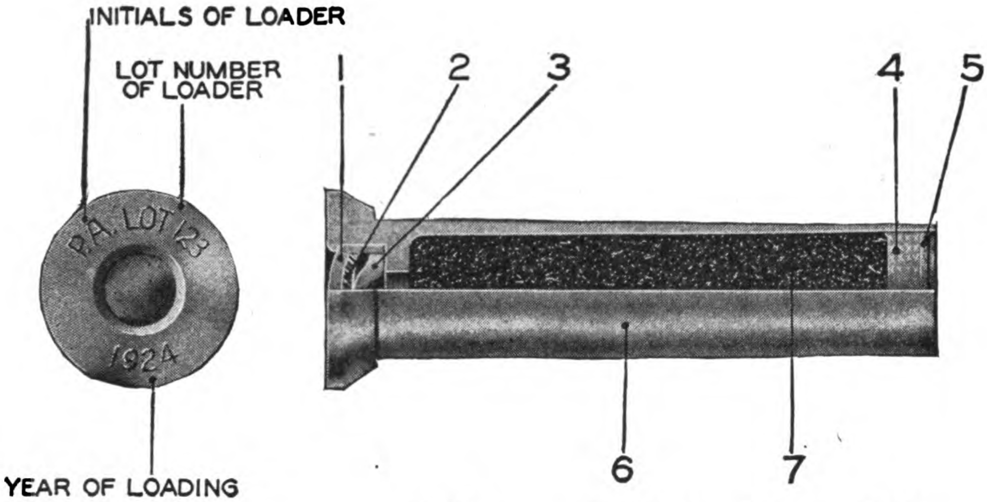
1. Body.
2. Wire.
3. Button.
10. Closing cup.
12. Primer charge, black-powder pellets.
13. Primer charge, loose black powder.
16. Gas check.
19. Friction composition.

FIGURE 72.—Friction primer M1914.



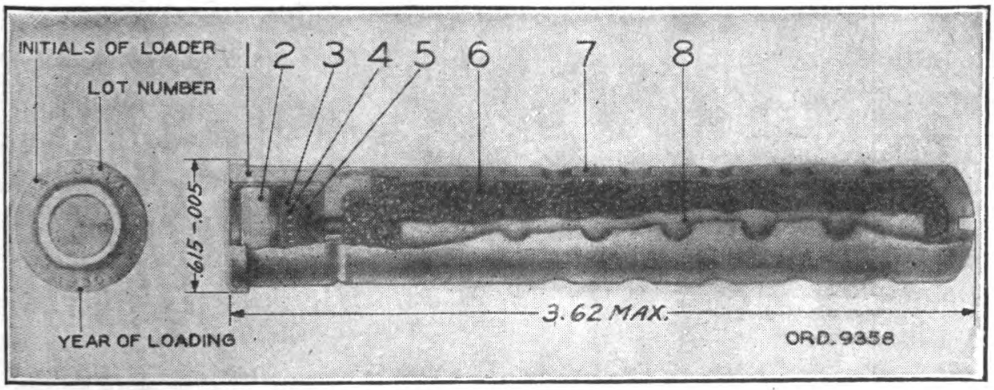
1. Body.
2. Wire.
3. Button.
4. Contact plug.
5. Plug insulator.
6. Insulator.
8. Contact sleeve.
10. Closing cup.
11. Contact wire.
12. Primer charge, black-powder pellets.
13. Primer charge, loose black powder.
14. Gun cotton.
15. Paper insulation.
26. Paper washer.

FIGURE 73.—Electric primer.



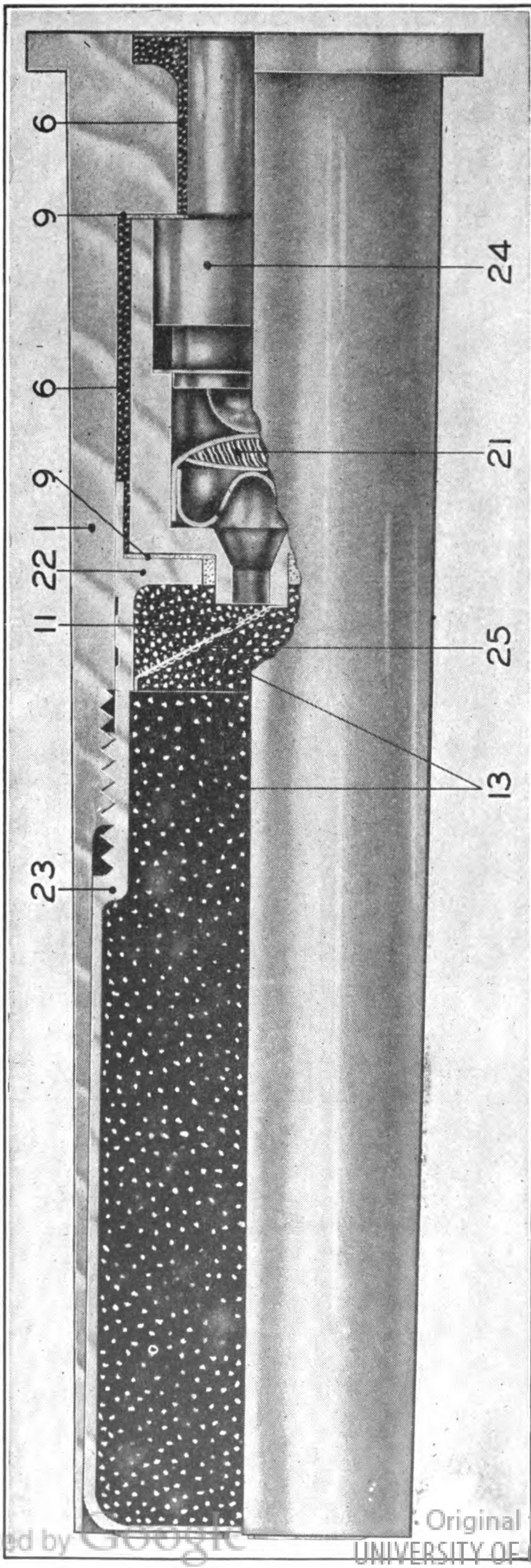
1. Percussion cup.
2. Percussion composition.
3. Anvil.
4. Wax.
5. Shellac.
6. Case.
7. Primer charge, black-powder.

FIGURE 74.—21-grain percussion primer Mk. II–A.



1. Head.
2. Firing plug.
3. Primer cup.
4. Percussion charge.
5. Anvil.
6. Charge (loose black powder).
7. Body.
8. Paper wrapper.

FIGURE 75.—100-grain percussion primer M1.



1. Body.
6. Insulators.
9. Insulating washers.
11. Contact wire.
13. Primer charge, loose black powder.
21. Primer cap.
22. Ignition cup.
23. Metallic seal.
24. Plunger.
25. Guncotton.

FIGURE 76.—Combination percussion-electric primer Mk. XVM1.

Q. What happens when the wire of the friction primer is pulled to the rear by the lanyard? *A.* The teeth at the inner end are pulled through the friction composition. This makes enough heat to ignite the composition, and the flame from this ignites the priming charge of black powder which fires the charge in the gun.

Q. What happens when electricity is sent through an electric primer? *A.* The electricity, going through the fine platinum wire, heats it until it is hot enough to ignite the gun cotton around it; then the flame from this cotton ignites the priming charge of black powder, which then fires the charge in the gun.

Q. What happens when the firing pin strikes the cap of a percussion primer? *A.* The blow of the firing pin forces the primer cap against the percussion composition, which is supported by the anvil. This causes the explosion of the percussion composition and the flame passes through the holes in the anvil and ignites the primer charge which then fires the charge in the gun.

Q. How should primers be handled? Should you take them apart? *A.* Very carefully as they are dangerous. Do not take them apart.

48. Fuzes.—*Q.* What is a fuze? *A.* A fuze is a device used to ignite the bursting charge of a projectile.

Q. When do the fuzes in seacoast projectiles ignite the bursting charge? *A.* They ignite the bursting charge upon impact or a very short time after impact. Some fuzes have delayed action to permit the projectile to penetrate before the bursting charge is ignited.

Q. Name the principal parts of a fuze. *A.* The body, plunger, firing pin, primer, detonator, booster, and adapter.

Q. Describe briefly each of the parts just named. *A.*

(1) The *body* is the part which houses the working parts of the fuze.

(2) The *plunger* is the mechanism which contains the firing pin or the primer. It is held stationary when the fuze is unarmed but when armed the plunger is free to move.

(3) The *firing pin* is the part of the fuze which strikes the sensitive explosive and causes the fuze to function.

(4) The *primer* is the part of the fuze which contains the sensitive explosive.

(5) The *detonator* is the small quantity of explosive which starts ignition of the booster charge.

(6) In some types the *booster* is a part of the fuze; in others it is inclosed in a separate casing. It is an additional charge of powder used to aid the detonator in exploding the bursting charge.

(7) The *adapter* is a metal bushing used to reduce the size of the opening in the base or point of the projectile and to form a seat for the fuze.

Q. Why is it not possible to use larger detonators and dispense with the booster? *A*. Detonators are made of very sensitive explosive compounds which would be very dangerous to handle in large quantities. It is safer to use a small detonator and obtain the required explosion by using an additional charge of less sensitive powder.

Q. When is a fuze said to be armed? *A*. When all the operating parts, the movement of which is necessary for the proper functioning of the fuze, are released so that the firing pin can strike the primer upon impact.

Q. How are fuzes used in seacoast projectiles armed? *A*. Fuzes are armed in either of two ways:

(1) Inertia.

(2) Centrifugal force.

In the first case the shock of discharge compresses a spring which permits the sleeve to move to the rear locking it to the primer plunger. The firing pin now projects above the front end of the sleeve, being held in place by a creep spring until impact. In the second case, the centrifugal force developed by the rotation of the projectile causes two side locking bolts to withdraw into recesses against the action of their springs. Upon impact the primer plunger moves forward.

Q. Name the fuzes used in the projectiles in your battery. *A*. —— fuze. (See amunition chart at end of this section.)

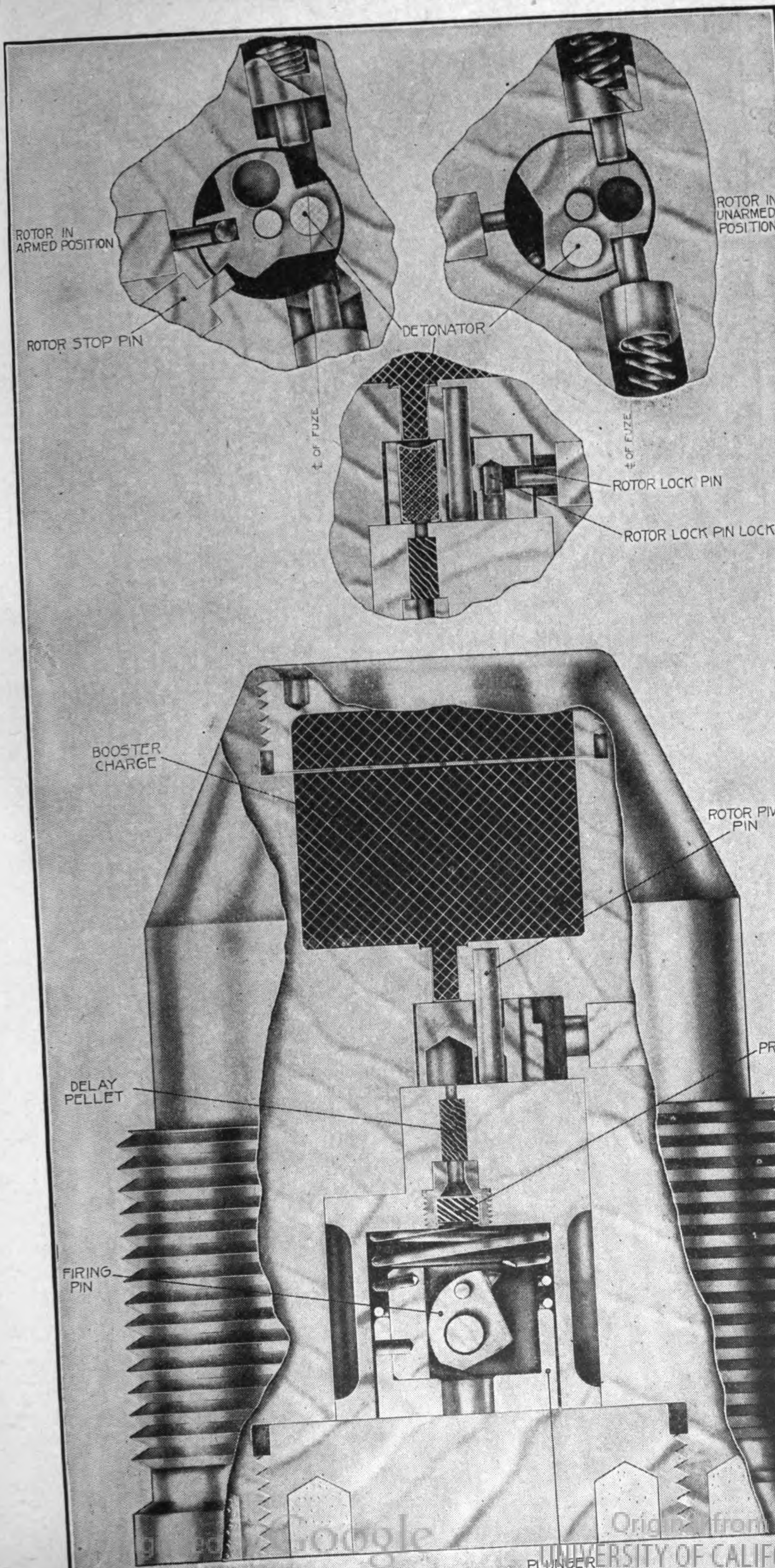
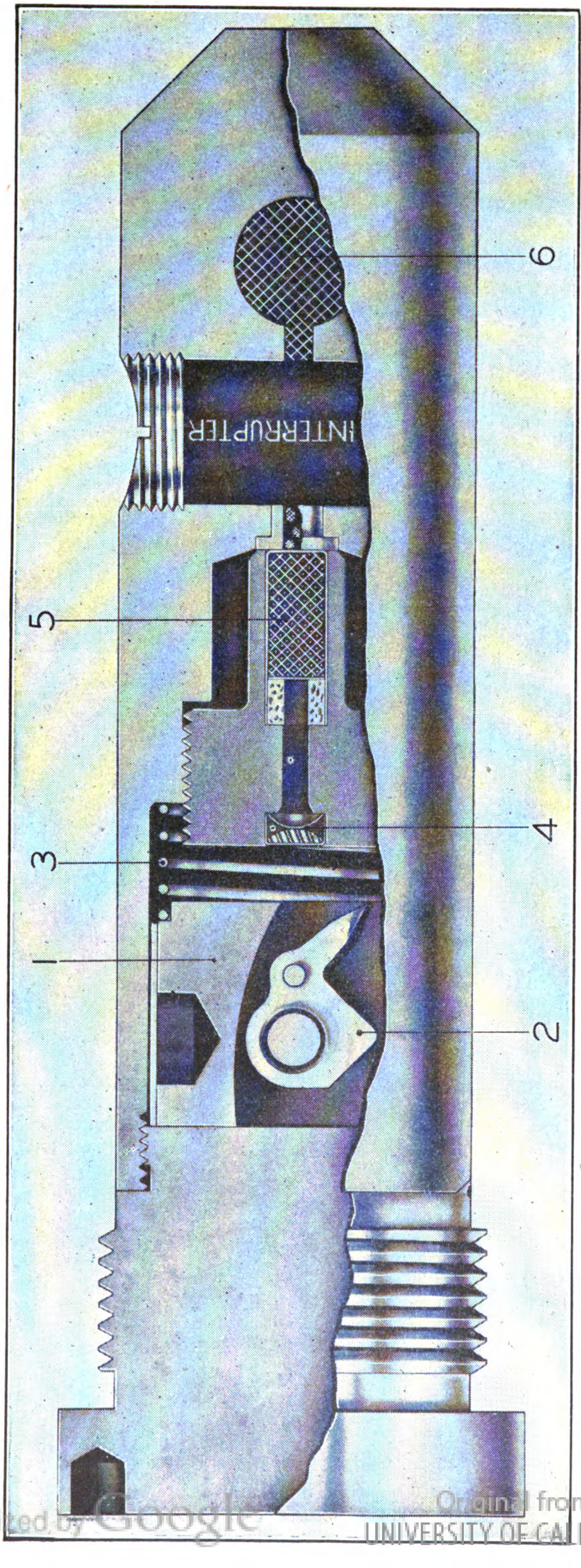
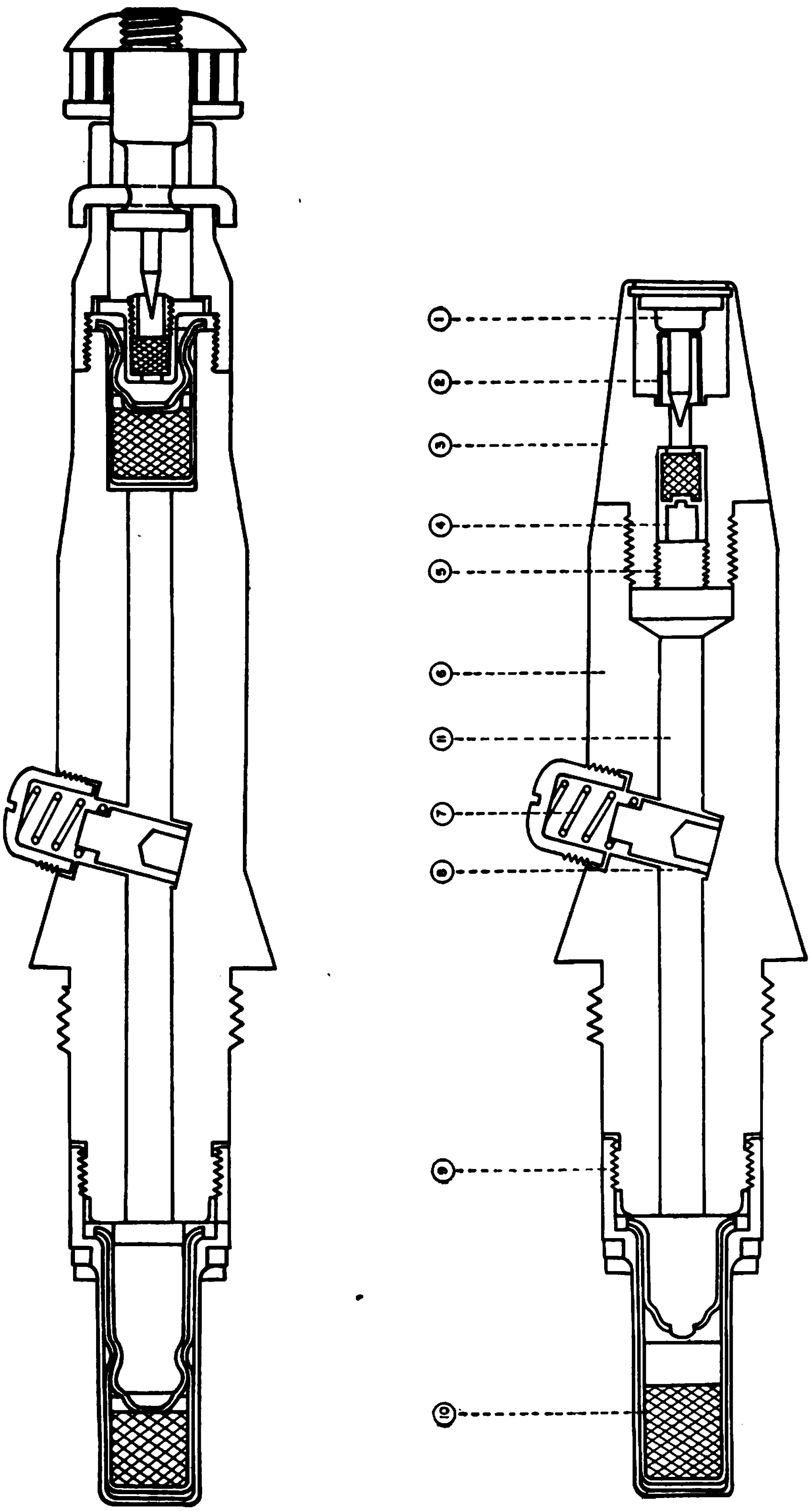


FIGURE 77.—Base detonating fuze Mk. X.



1. Percussion plunger.
2. Firing pin.
3. Restraining spring.
4. Percussion primer.
5. Detonator.
6. Booster charge.

FIGURE 78.—Base detonating fuze Mk. V. (medium caliber).



1. Firing pin assembly.
2. Firing pin support.
3. Head.
4. Detonator assembly.
5. Detonator retaining screw.
6. Body.
7. Interrupter spring.
8. Interrupter.
9. Lower detonator socket.
10. Lower detonator assembly.
11. Flash hole.

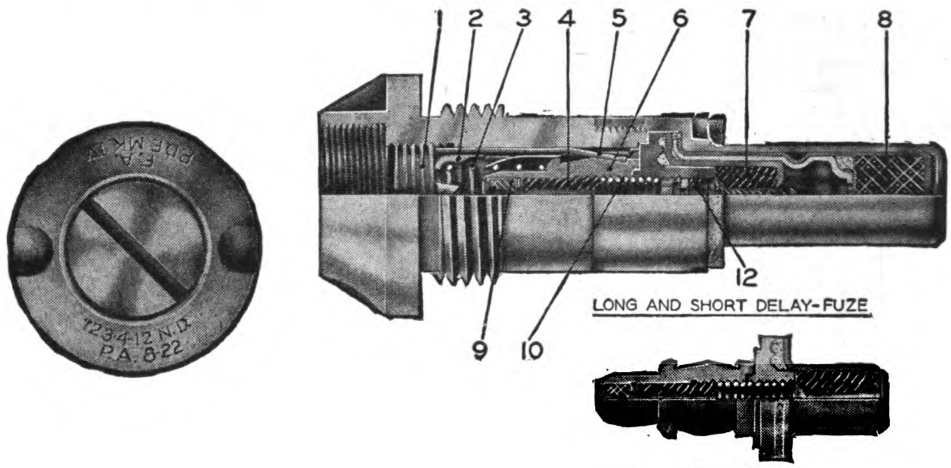
FIGURE 79.—Point detonating fuze M46.

49. Misfires.—*Q*. What are the two causes of misfire? *A*.

(1) Failure of the primer to fire.

(2) Failure of the powder charge to ignite.

Q. What precautions should be observed when the piece fails to



1. Firing pin.
2. Arming casing.
3. Arming spring.
4. Black-powder pellet.
5. Safety casing.
6. Percussion plunger.
7. Relay powder.
8. Detonator.
9. Percussion primer.
10. Retard spring.
12. Delay pellet.

FIGURE 80.—Point detonating fuze Mk. IV and Mk. IV-star.

fire? *A*.

(1) At least three attempts should be made to fire the primer.

(2) Wait 2 minutes after the last attempt before removing the primer. To remove the primer use a stick or rod, with a net and hook or eye, which will eject the primer or, in the case of the 155-mm gun, unscrew the firing mechanism. The stick should be long enough to permit the operator to stand clear of the breech while he removes the primer.

(3) If the primer has *not* been fired, no further delay is necessary. Insert a new primer and continue the firing.

(4) If the primer *has* fired, keep all persons away from in rear of the breech; train the gun on the target or on a safe point in the field of fire; wait 10 minutes before opening the breech.

AMMUNITION CHART
For matériel manned by Coast Artillery

Gun	Projectile				Fuze		Primer [1]		Powder charge	
	Kind	Type	Model	Weight	Model	Kind	Kind	Size	Kind	Weight [2]
				Pounds				*Grains*		*Pounds*
3-inch seacoast gun M1902, M1903.	Shell	HE	1915	15	Mk. V	B. D	Percussion	300	Fixed	5
	do	HE	Mk. I	15	M1907M	21-second combination.	do	300	do	5
				Grains						*Grains*
Subcaliber .30	Bullet			174					do	35
				Pounds						*Pounds*
3-inch AA gun M1917, M1918, M1925, M1, M2, M3, M4.	Shrapnel		Mk. I	15	Mk. III A1	21-second time	do	300	do	5
										Pounds Ounces
	do		Mk. I	15	Mk. III A1	do	do	300	do	4 10
	Shell	HE	Mk. IX	12.7	Mk. III A1	do	do	300	do	4 14
	do	HE	M42	12.73	Mk. III A2	do	do	300	do	4 14
	do	HE	M42	12.92	M43	Mechanical-time.	do	300	do	4 14
										Pounds
105-mm AA gun M3	do	HE	M38 A1	32.85	M43	do	do	300	do	11
	do	HE	M38	32.85	M2	do	do	300	do	11
										Pounds
6-inch seacoast gun	do	HE	Mk. II	90.3	Mk. IV-star	P. D	Electric		Separate-loading.	26; 29
M1897MI, M1900, M1903, M1905, M1908, M1908MI, M1908MII.	do	AP	1911	108	Mk. V	B. D	do		do	29; 32
	Shot	AP	1911	108	Mk. V	B. D	do		do	29; 32
										Grains
Subcaliber 1.457-inch gun	Shell			1.057			Ignition	20	Fixed	1,110

Footnote at end of table.

AMMUNITION CHART—Continued
For matériel manned by Coast Artillery

Gun	Projectile Kind	Projectile Type	Projectile Model	Projectile Weight	Fuze Model	Fuze Kind	Primer[1] Kind	Primer[1] Size	Powder charge Kind	Powder charge Weight[2]
				Pounds				Grains		Pounds
155-mm gun (G.P.F.) M1918MI.	Shell	HE	Mk. III	95	M47 or Mk. IV-star.	P. D	Percussion	21	Separate-loading.	26.2
	do	HE	Mk. III	95.38	M46	P. D	do	21	do	26.2
	Shrapnel		Mk. I	95	M1907	45-second combination.	do	21	do	26.2
	Shell	Chemical	Mk. VII	96.79	M46	P. D	do	21	do	26.2
										Grains
Subcaliber 37-mm gun	do	LE	Mk. I	1.097	Mk. I	Base-percussion.	do	20	Fixed	500
										Pounds Ounces
8-inch seacoast gun M1888, M1888MI, M1888MII.	do	HE	Mk. I	200	M47 or Mk. IV-star.	P. D	Electric		Separate-loading.	70 10
	Shot	AP	1911	323	Mk. V	B. D	do		do	82 6
	Shell	AP	1911	323	Mk. V	B. D	do		do	82 6
	Projectile	AP	Navy	260	Mk. II	Tracer-detonator.	do		do	84 8
										Grains
Subcaliber 1.457-inch gun	Shell			1,057			Ignition	20	Fixed	1,110
										Pounds
10-inch seacoast gun M1888, M1888MI, M1888MII, M1895, M1895MI, M1900.	do	HE	Mk. IV	510	M47; M46; or Mk. IV-star.	P. D	Electric		Separate-loading.	160
	do	AP	Mk. III	617	Mk. V	B. D	do		do	155; 176
	Shot	AP	1911	617	Mk. V	B. D	do		do	155; 176
										Grains
Subcaliber 1.457-inch gun	Shell			1.057			Ignition	20	Fixed	1,110

										Pounds
12-inch seacoast gun, M1888, M1888MI, M1888MI½, M1888MII, M1895, M1895MI, M1900.	do	HE	Mk. VI	700	Mk. V	B. D	Electric		Separate-loading	220
	do	HE	Mk. X	712	M47; M46; or Mk. IV-star.	P. D	do		do	220
	do	AP	1912A	1,070	Mk. X	B. D	do		do	295; 270
	Shot	AP	1913	1,070	Mk. X	B. D	do		do	295; 270
	Shell	AP	Mk. I	900	Mk. X	B. D	do		do	270
	Projectile	AP	Mk. XVI	975	Mk. X	B. D	do		do	295; 270
	do	AP	Navy	870			do		do	248
										Grains
Subcaliber 1.457-inch gun	Shell			1,057			Ignition	20	Fixed	1.110
										Pounds
Subcaliber 75-mm gun (see note).	do		Mk. I	12.18	Mk. IV (inert)	P. D	Percussion	100	do	1.72
										Pounds
12-inch mortar, M1890, M1890MI, M1908, M1912.	do	HE	Mk. VI, VIII	700	Mk. V	B. D	Electric		Separate-loading	63
	do	HE	Mk. VIA	692.2	M47; M46; or Mk. IV-star.	P. D	do		do	63
	do	HE	Mk. XI	712	M47; M46; or Mk. IV-star.	P. D	do		do	63
	do	DP	1911A	700	Mk. X	B. D	do		do	63; 89
	do	DP	1898	824	Mk. X	B. D	do		do	58
	do	DP	1898	1,046	Mk. X	B. D	do		do	47; 60
	do	DP	Mk. XXVIII	1,046	Mk. X	B. D	do		do	47; 60
										Ounces
Subcaliber 2.95-inch gun	Shot	Solid		18			Ignition	100	Fixed	4¼, 5, or 6 (3 zones)
										Pounds
14-inch seacoast gun, M1907, M1907MI, M1909, M1910, M1910MI, M1920MI, M1920MII.	Projectile	HE	Mk. XI, M2A1	1,208	Mk. V	B. D	Combination		Separate-loading	480
	do	AP	Mk. VI	1,560	Mk. X	B. D	Electric; combination.		do	332; 460
	do	AP	Mk. VIIIM9A1	1,400	Mk. X	B. D	do		do	332; 460
	Shell	AP	1909	1,660	Mk. X	B. D	Electric		do	332; 435

Footnote at end of table.

AMMUNITION CHART—Continued

For matériel manned by Coast Artillery

Gun	Projectile				Fuze		Primer [1]		Powder charge	
	Kind	Type	Model	Weight	Model	Kind	Kind	Size	Kind	Weight [2]
				Pounds				*Grains*		*Grains*
Subcaliber 1.457-inch gun	Shell			1,057			Ignition	20	Fixed	1,110
										Pounds
Subcaliber 75-mm gun (see note).	do		Mk. I	12.18	Mk. IV (inert)	P. D	Percussion	100	do	1.72
										Pounds
16-inch seacoast, gun M1895, M1919, M1919MII, M1919MIII, Mk. II (Navy).	Projectile	AP	Mk. V	2,340	Mk. X	B. D	Electric; combination.		Separate-loading	650; 832
	do	AP	Mk. II M2	2,100	Mk. X	B. D	Combination		do	832
	do	AP	Mk. IX	2,340	Mk. X	B. D	Electric; combination.		do	650; 832
										Grains
Subcaliber 1.457-inch gun	Shell			1,057			Ignition	20	Fixed	1,110
Subcaliber 75-mm gun (see note).	do		Mk. I	12.18	Mk. IV (inert)	P. D	Percussion	100	do	1.72
										Pounds
16-inch howitzer M1920	Projectile	AP	Mk. II M2	2,100	Mk. X	B. D	Combination		Separate-loading	296
Subcaliber 75-mm gun	Shell		Mk. I	12.18	Mk. IV (inert)	P. D	Percussion	100	Fixed	1.72

[1] On guns not equipped with the electric firing mechanism a friction primer is used. It is also used in emergency when the electric equipment fails.

[2] The weights given for propelling charges are approximate only, as the weights vary for different powder lots. The exact weight of each charge will be found on the powder tag attached to it.

NOTE.—75-mm gun, subcaliber, for:
- 12-inch barbette carriage, M1917.
- 14-inch railway carriage, M1920.
- 16-inch barbette carriage, M1919.

Section II

HANDLING AMMUNITION

50. General.—*Q*. Under whose supervision should ammunition be handled? *A*. Under a competent person who understands thoroughly the hazards and risks involved.

Q. Name some hazardous explosives. *A*. Detonators, bulk explosives, and smokeless powder.

Q. What precautions should be observed by personnel engaged in handling explosives? *A*. No metal tools of any kind should be used by any personnel engaged in handling explosives. Extreme care should be taken to insure that such personnel do not have on or about their persons any metal tools, nails, matches, cartridges, firearms, or similar material, and that their shoes are not shod with iron nails or other metallic substances which are liable to cause a spark. Only shoes which have soles of felt or soft leather should be worn.

Q. In case explosives are spilled from a container, what will be done? *A*. All work will be stopped until the explosives have been swept up and the area has been neutralized.

Q. Where may damaged containers be repaired? *A*. In the open, or in a building especially provided for this purpose, at least 100 feet from the magazine, boat, or truck containing ammunition.

51. Storing ammunition.—*Q*. If ammunition must be stored outside is it necessary to protect it from the sun? *A*. Yes. It must be covered to protect it from the direct rays of the sun. However, air must circulate freely through the pile.

Q. What ammunition will be stored in a battery storeroom? *A*. The small quantity of small-arms ammunition required for current use.

Q. Where will small-arms ammunition be stored? *A*. In any magazine or warehouse which offers good protection against the weather.

Q. Where will all other ammunition be stored? *A*. In special magazines such as described in Technical Manuals.

Q. How is ammunition segregated in storage? *A*. Ammunition is placed in neat, stable piles by lot number and is raised off the floor on 2-inch battens.

Q. How high will ammuntion be piled? *A*. This depends on the strength of the container, but piles should not exceed the height of the eaves in magazines.

Q. What does an acid odor in a powder magazine indicate? *A.* Danger—powder is decomposing.

Q. What testing instruments are placed in powder and ammunition magazines? *A.*

(1) Maximum and minimum thermometer.

(2) Hygrometer.

(3) Litmus paper.

Q. How is air circulation provided in ammunition storage? *A.* By dunnage or by cleats on the boxes.

Q. In case of doubt as to the condition of ammunition in storage, who is notified? *A.* The local ordnance officer.

CHAPTER 8

SEARCHLIGHTS

SECTION I

DRILL OF ANTIAIRCRAFT SEARCHLIGHT SECTION

52. Organization.—Instruction in drill will be practical, the candidate performing the duties of such members of the searchlight section as may be required. (See table IX.)

Q. Of what personnel does the searchlight section consist? *A*. The searchlight section consists of one chief of section (a sergeant); one searchlight commander (a corporal); and ten privates, as follows: No. 1, azimuth listener; No. 2, elevation listener; No. 3, acoustic corrector operator; No. 4, telephone operator; No. 5, azimuth controller; No. 6, elevation controller; No. 7, searchlight operator; No. 8, power plant operator and chauffeur, truck No. 2; No. 9, chauffeur, truck No. 1; No. 10, basic assistant to No. 8.

Q. What are the names of the squads in the searchlight section? *A*.
(1) Sound locator squad.

(2) Searchlight squad.

Q. Of what personnel does the sound locator squad consist? *A*. See figure 81.

Q. Of what personnel does the searchlight squad consist? *A*. See figure 81.

53. Prepare for action.—*Q*. Who gives the command PREPARE FOR ACTION? *A*. The chief of section gives the command PREPARE FOR

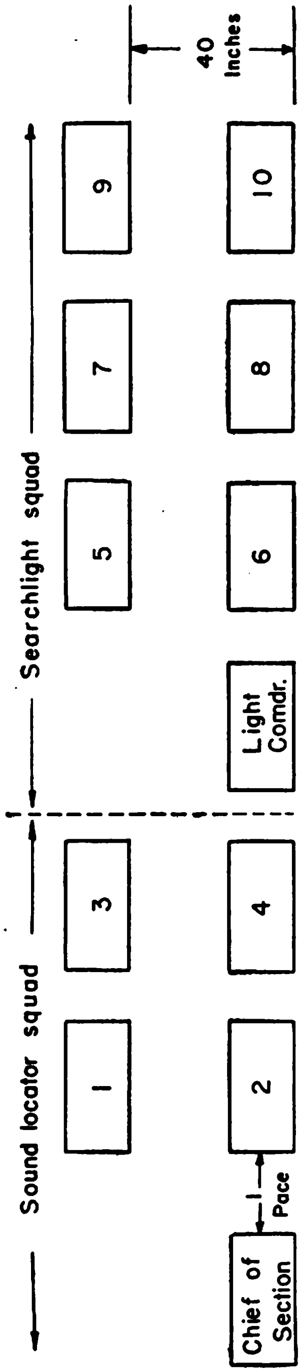


FIGURE 81.—Formation of personnel of antiaircraft searchlight section.

ACTION, after the trucks of the section have reached the vicinity of the searchlight position. The command is repeated by the searchlight commander.

Q. What is done after the command PREPARE FOR ACTION is given? *A*. The chief of section designates the positions at which the searchlight, control station, power plant, and sound locator are to be placed. Truck No. 1 is driven to the searchlight position by No. 9, after which Nos. 1, 2, 5, 7, and 9 unload, set up, and level the searchlight under supervision of the chief of section. No. 7, searchlight operator, remains at the searchlight, connecting yellow, red, and blue cables to the junction box after they have been delivered by truck No. 2, and otherwise prepares the light for action. No. 7 also removes the extended hand controller from truck No. 1 and places it close to the searchlight.

Q. After the searchlight is in position, what is done? *A*. Truck No. 1 is driven to the control station position under supervision of the chief of section. Nos. 1, 2, and 5 set up the control station. No. 5 procures the automatic rifle from the truck, places it near the control station, and then levels the control station. When the red cable has been laid to the control station by the personnel of truck No. 2, No. 5 connects the cable to the control station.

Q. What duties do the personnel of truck No. 1 perform next? *A*. Truck No. 1 then is driven to the sound locator position where Nos. 1, 2, and 9 unload and set up the sound locator under the supervision of the chief of section. When the blue cable has been laid to the sound locator position by the personnel of truck No. 2, No. 1 connects the cable to the sound locator. Nos. 1 and 2 level the sound locator, No. 2 installs the pantograph and drives stakes to indicate the direction of advanced listening posts and the other four searchlights of the platoon. No. 9 then drives the truck to the parking area selected by the chief of section, checks his truck, and then performs duties as indicated by the chief of section.

Q. What do the personnel of truck No. 2 do at the command PREPARE FOR ACTION? *A*. After finding out where the equipment is to be located, No. 8 drives truck No. 2 to the power plant position, where Nos. 3, 6, 8, and 10 unload the power plant. No. 8, the power plant operator, places the automatic weapon near the power plant. Nos. 3 and 6 carry the power cable reel to the rear of the truck and pay out the positive and negative yellow power cables as truck No. 2 moves toward the searchlight position. No. 10 holds the power cables in place as truck No. 2 moves off, and then connects the cables to the power plant. Thereafter No. 10 performs duties as indicated

by the chief of section. When truck No. 2 arrives at the searchlight the power cable reel is moved out of the way and the red and blue cable reels are moved to the rear of the truck. The truck then moves toward the control station, paying out the red cable. If the sound locator is located so that blue cable to it may also be payed out, this is done at the same time, otherwise, each cable is laid separately. When both are laid at the same time, No. 3 pays out the *blue* cable and the searchlight commander the *red* cable. No. 6 walks behind the truck, forcing both cables to one side so as to allow passage for vehicles without damage to the cables. If each cable is payed out separately, No. 3 pays out both red and blue cables; the searchlight commander assists either No. 3 or No. 6, as he deems necessary. After the cables are laid, truck No. 2 is driven to the prescribed parking area by No. 8, who checks his truck and thereafter performs duties as indicated by the chief of section. Nos. 3 and 6 proceed to the sound locator and control station positions, respectively.

Q. What are the duties of No. 4, the telephone operator, at the command PREPARE FOR ACTION? *A*. After learning from the chief of section where the telephone line is located, he leaves truck No. 2 and proceeds on foot to connect his telephone to establish communication with platoon headquarters. When this is accomplished he reports to the chief of section.

Q. Do the personnel of truck No. 2 wait until the duties of the personnel of truck No. 1 are completed before starting their duties? *A*. No. The personnel of truck No. 2 perform their duties at the same time to avoid unnecessary delay.

54. Examine equipment.—*Q*. Who gives the command EXAMINE EQUIPMENT? *A*. The chief of section gives the command EXAMINE EQUIPMENT, as soon as all equipment is placed properly and cables are connected.

Q. What is done at the sound locator at the command EXAMINE EQUIPMENT? *A*. The chief of section verifies the proper functioning of all equipment and personally supervises the orientation and synchronization of the unit. Nos. 1 and 2 test the elevating and traversing mechanisms, and verify that the sound locator is leveled. Nos. 1, 2, and 3 then orient the sound locator. No. 3 inspects the acoustic corrector, is given the parallax correction by the chief of section and sets it on the parallax cam scale, and assists Nos. 1 and 2 with the orientation. No. 2 also tests the cut-out switch which reduces noise from the data transmitters. Nos. 1 and 2 then adjust their listening helmets for fit and as a test connect each helmet properly to the aluminum elbows fixed to the flexible tubing from the horns.

No. 4 tests communication to the platoon command post. Any failure of equipment to function properly is reported to the chief of section.

Q. What is done at the control station at the command EXAMINE EQUIPMENT? *A*. The searchlight commander inspects the proper functioning of the searchlight, power plant, and control station. He directs the orientation and synchronization of the searchlight and control station with the sound locator. Nos. 5, 6, and 7 assist in the orientation and synchronization. Nos. 5 and 6 inspect the azimuth and elevation control mechanisms, and also test the distant electric control (D. E. C.) in azimuth and elevation, respectively. No. 5 inspects the automatic rifle to include the proper supply of ammunition. No. 6 tests the buzzer by means of the buzzer signal switch.

Q. What is done at the searchlight when the command EXAMINE EQUIPMENT is given? *A*. No. 7 inspects all cable connections and the proper leveling of the searchlight. He then assures himself that the dynamotor is functioning, that the lamp is carboned, and that spare carbons are on hand. When the power is delivered from the power plant he tests the proper functioning of the lamp mechanism and feeding of the carbons. *Important: No. 7 assures himself that the arc is functioning properly, carbons are positioned properly, and that the arc operates at 78 volts with 150 amperes flowing through it. The functioning of the arc is verified only when authorized by the platoon commander, as striking the arc may give away the searchlight position.* The searchlight commander, assisted by No. 7, orients and synchronizes the searchlight. Nos. 5 and 6, at the control station, assist in these operations.

Q. What is done at the power plant at the command EXAMINE EQUIPMENT? *A*. No. 8 examines the power plant. He inspects the oil, water, and gasoline supply to insure a sufficient supply, and assures himself that cables are connected properly. No. 8 then starts the engine and adjusts the generator voltage. (See Operator's Manual furnished with each power plant for exact procedure.) When No. 7 is permitted to strike the arc, a more exact adjustment of the voltage and current may be made by No. 8, since No. 7 can tell No. 8 what voltage and current are delivered to the searchlight. No. 8 also examines the automatic rifle and assures himself that a sufficient supply of ammunition is on hand.

Q. What do Nos. 9 and 10 do at this time? *A*. No. 9, after driving truck No. 1 to the prescribed parking area, checks the water, gasoline, oil, and operation of his truck. After truck No. 2 is parked in the prescribed parking area, No. 10 inspects it for water, gasoline, oil,

and correct operation. Nos. 9 and 10 check concealment of their respective trucks. No. 10 then assists No. 8 at the power plant.

55. Miscellaneous commands.—*Q*. Who gives the command REST and what is done? *A*. If no action is probable, or when ordered by the platoon commander, the chief of section commands: REST. The command is repeated by the searchlight commander. During rest periods the chief of section arranges men in reliefs for the necessary posts as shown in the drill table under column headed REST.

Q. What is done at the command STAND BY? *A*. This command is given by the chief of section when a target is detected, when an adjacent light goes into action, or when he receives the order STAND BY from the platoon commander. The order is repeated by the searchlight commander. At this command all men of the searchlight section are alerted and take their respective posts, performing the duties outlined in the drill table under column headed STAND BY.

Q. What is done at the command TRACK? *A*. This command is given by the chief of section when the sound locator crew reports "On target." The command is repeated by the searchlight commander. Each man performs his duties so that the light may go into action at the proper command. See drill table under column headed TRACK for duties performed by each member of the section.

Q. Who gives the command IN ACTION and what is done? *A*. The chief of section gives this command. It is repeated by the searchlight commander who signals No. 7, using the buzzer. No. 7 then closes the arc switch. Exact duties for each man appear under the column headed IN ACTION in the drill table.

Q. Who gives the command OUT OF ACTION, and what is done at this command? *A*. The command is given by the chief of section. It is repeated by the searchlight commander who signals No. 7, using the buzzer, whereupon No. 7 opens the main arc switch and extinguishes the arc. Other duties are as listed in column headed OUT OF ACTION in the drill table.

Q. If a new target is assigned, what is the proper command? *A*. CHANGE TARGET. The chief of section causes the sound locator and searchlight to pick up the new target as outlined in column headed CHANGE TARGET in the drill table.

Q. Who gives the command MARCH ORDER? *A*. On order from the platoon command post, the chief of section gives this command. The duties performed are the opposite of those performed in PREPARE FOR ACTION. Exact duties are listed in the drill table under the column MARCH ORDER.

56. Drill table.—*Q*. What are the duties of the antiaircraft searchlight section? *A*. See table IX in back of Manual.

Section II

DRILL OF SEACOAST SEARCHLIGHT SECTION

57. **Fixed seacoast searchlight.**—The examination in drill will be practical, the candidate performing the duties of such members of the searchlight squad as may be required. (See table X.)

Q. Of what personnel does the searchlight squad consist? *A.* The searchlight squad consists of a light commander (corporal) and three privates as follows: No. 1, controller operator; No. 2, light operator; No. 3, power plant operator.

Q. How are searchlights designated? *A.* Looking seaward, fixed searchlights of a harbor defense are designated consecutively from right to left by numbers?

Q. How is the operation and control of searchlights coordinated? *A.* By certain definite commands having a prescribed meaning.

Q. What is the meaning of the command PREPARE FOR ACTION? *A.* The light will be put in its operating position, the power plant started, the light and the control means tested, and the personnel will take their posts.

Q. What is the meaning of the command REST? *A.* The designated light, if in action, will be put out and the power plant shut down. Personnel except telephone operators will fall out but will remain in the immediate vicinity.

Q. What is the meaning of the command STAND BY? *A.* The designated light will be kept ready for action, and if the position of the target is known, the light will be kept trained on it.

Q. What is the meaning of the command IN ACTION? A. The designated searchlight will be put in operation immediately. Thus EIGHT, IN ACTION signifies that searchlight No. 8 is to be put in operation.

Q. What is the meaning of the command OUT? *A.* The designated searchlight is to be put out immediately and places the searchlight in the condition of STAND BY.

Q. What is the meaning of the command LOCAL CONTROL? *A.* The designated light will be operated by the hand control provision at the light. REMOTE CONTROL means that the light will be controlled by means of the electric controller located at some distance from the light.

Q. What is the meaning of the command AZIMUTH, FOUR ZERO? *A*. The designated searchlight will be set at the stated azimuth, thus TWO, AZIMUTH FOUR ZERO.

Q. What is the meaning of the command SEARCH? *A*. The designated searchlight will be used to search its entire area of responsibility. If the search of a certain subarea is desired, the command is: TWO (or other light number), SEARCH LYNNHAVEN (or other subarea). The searchlight may be caused to search left or right by adding LEFT or RIGHT to the command SEARCH. It will continue to do so until ordered to halt.

Q. What is the meaning of the command FOLLOW? *A*. The beam of the searchlight will be kept on the target even if the latter passes out of the area which the light has been ordered to search, thus TWO, FOLLOW.

Q. What is the meaning of the command COVER? *A*. The searchlight designated first will pick up the target being illuminated by another light, thus EIGHT, COVER TWO.

Q. What is the meaning of the commands FOCUS, SPREAD, CONTRACT, RIGHT, LEFT, RAISE, LOWER, HALT? *A*. These are commands used to accomplish the objects indicated by them. The first three have a direct application to a regulation of the beam condition.

Q. What is the meaning of the commands SLOW, SLOWER, FAST, FASTER? *A*. The rate of searching is regulated by these commands.

Q. What is the meaning of the command ELEVATE? *A*. At this command the beam is raised 30° above the horizontal and held there until further orders.

Q. What is the meaning of the command TWO CONTROLLER, TWO LIGHT? *A*. These commands are used to distinguish between the telephone operator on the controller and the telephone operator at the light. The commands as above will always be given designating the proper light.

58. Drill table.—*Q*. What are the duties of fixed seacoast searchlight squad? *A*. See table X.

59. Mobile and portable seacoast searchlight.—The examination in drill will be practical, the candidate performing the duties of such members of the searchlight squad as may be required. (See table XI).

Q. Of what personnel does the searchlight squad consist? *A*. The searchlight squad consists of a light commander (corporal) and four privates as follows: No. 1, controller operator; No. 2, light operator; No. 3, power plant operator; No. 4, chauffeur.

TABLE X.—*Drill table—Drill of the fixed seacoast searchlight squad*

Details	PREPARE FOR ACTION	REST	STAND BY	IN ACTION	OUT	CLOSE STATION
Light commander.	Supervises the preparation of the light, power plant, and electric control for action. Checks the establishment of communication. Remains at the light prepared to take over manual control of the light if distant electric control fails or is not used. Reports. "Light in order" when he has received the reports of other members of the squad.	After reporting in order and if no warning of a target has been received, he commands: REST. He causes all personnel to remain in the immediate vicinity of their posts prepared to assume the "stand by" without delay.	Gives or repeats: STAND BY. Sees that all members of the squad are alerted and at their posts. Reports "No. —— on target," if a known target has been designated and local control is being used. Takes post at the elevating and traversing gear if local control is being used.	Commands: IN ACTION, if hand control is used. Thereafter maneuvers the light according to directions received from the controller operator by telephone. If distant electric control is being used he supervises work of the light squad.	Commands: OUT, if hand control is used. Assures himself that squad remains on "stand by."	Repeats command. Assures himself that equipment is replaced and checked for condition.
No. 1 (controller operator).	Checks telephone communication with the light and with searchlight officer's station. Synchronizes his controller with the searchlight and checks its operation. Reports "Controller in order."	Turns off arc, if on and distant electric control is being used. Remains near his telephone.	Takes post at the controller on the alert. With distant electric control in use, and if a known target has been designated, he traverses the light to the designated azimuth and reports "No. —— on target." If hand control is used, prepares to control the light by verbal means.	If distant electric control is being used, he closes his lamp switch, turning on the arc, and maneuvers the light according to instructions of the officer directing the action of the light. He keeps any target in the side of the beam nearest the interested personnel. If hand control is used he maneuvers the light verbally by telephone.	Relays command to the light. If distant electric control is being used he turns his lamp switch to "off." Assumes "stand by" status.	Replaces his equipment, checking it for condition and necessary repairs.

TABLE X.—*Drill table—Drill of the fixed seacoast searchlight squad*—Continued

Details	PREPARE FOR ACTION	REST	STAND BY	IN ACTION	OUT	CLOSE STATION
No. 2 (light operator).	Procures cleaning and lubricating material. Moves the light from its shelter. Examines the light and sees that fresh carbon is in place (positive and negative). Verifies that spare carbons are on hand. Working with No. 1, assists in orienting and synchronizing the light and controller. Tests hand and distant electric control mechanism. *If permitted*, tests and adjusts lamp mechanism by turning on the arc. Reports to light commander "Light in order."	Turns off arc, if on and hand control is being used. Checks his light and makes minor adjustments. Remains in the immediate vicinity of the light.	Takes post on the alert. He switches to hand or distant electric control as directed. Prepares to observe the operation of the lamp mechanism and make such adjustments as may be necessary.	If distant electric control is being used he observes the functioning of the light. If hand control is being used he turns the lamp switch to "on," turning on the arc. He reports the remaining time length of the carbon every 15 minutes. He recarbons the arc at the first break in operation after positive carbon is half consumed.	If distant electric control is being used, no duties. If hand control is being used, turns his lamp switch to "off." Assumes "stand by" status. Recarbons arc and checks lamp mechanism if needed.	Recarbons arc. Cleans mirror. Lubricates light mechanism. Rolls light into shelter. Replaces equipment, noting condition and repairs necessary.
No. 3 (power plant operator).	Examines and checks power plant, seeing that gasoline, oil, and water supply is sufficient. Starts the engine and builds up voltage to no-load value (115 volts). Checks operation of cooling fan. Checks pressures indicated by oil gages. When searchlight is turned on, checks operation under load.	Shuts down power plant if running. Checks engine and generator, making minor adjustments if necessary.	Starts power plant and checks operation.	No duties.	No duties.	Shuts down engine, if running. Checks quantity of gas and oil on hand. Notes condition of equipment with repairs necessary. Enters hours of run in log. If weather is cold, prepares cooling system against freezing. Cleans equipment and engine room.

Q. How are mobile and portable seacoast searchlights designated? *A*. Sites selected for occupation by such searchlights are designated consecutively from right to left, looking seaward, by prime numerals. Searchlights, when occupying a given site, are designated by the number of that site.

Q. How is the operation and control of mobile and portable searchlights coordinated? *A*. By definite commands having a prescribed meaning. (For various commands and their use see pars. 57 and 58.)

60. Drill table.—*Q*. What are the duties of the mobile and portable seacoast searchlight squad? *A*. See table XI in back of Manual.

Section III

NOMENCLATURE OF ANTIAIRCRAFT SEARCHLIGHT

61. Searchlights.—*a*. *General.*—*Q*. In learning the names of the various parts, what should you bear in mind? *A*. In addition to learning the names of the various parts, you should also find out for what purpose each part is used, and how it works.

Q. What is the maximum range of a searchlight? *A*. This depends on atmospheric conditions. An average value of 10,000 yards is the approximate maximum range under good conditions.

Q. What shape or type is the mirror of the searchlight? *A*. It is a metal parabolic mirror. When light is emitted from a source (the carbon arc) at the *focal point* of the mirror, the light is reflected from the mirror in *parallel rays of light.*

Q. What is the beam candle power of the searchlight? *A*. 800 million candlepower.

Q. What causes such a great amount of light in the beam? *A*. This is caused by the burning of gases in the positive carbon crater.

Q. In general, how long do the positive and negative carbons burn? *A*. All carbons burn for approximately 1½ hours.

Q. In how many ways may the carbons be fed? *A*. Three: automatically, semiautomatically, or by hand.

Q. How can you tell the positive carbon from the negative carbon? *A*. The positive carbon is longer and thicker than the negative carbon. When issued, the positive carbon is 22 inches long and 0.633 inch in diameter; the negative carbon is 12 inches long and 0.434 inch in diameter.

Q. Which carbon burns out first? *A*. The positive carbon. For this reason the arc must be watched carefully so that the positive nose cap is not melted.

Q. Do all antiaircraft searchlights have an extended hand controller for pointing the light manually? *A*. Yes.

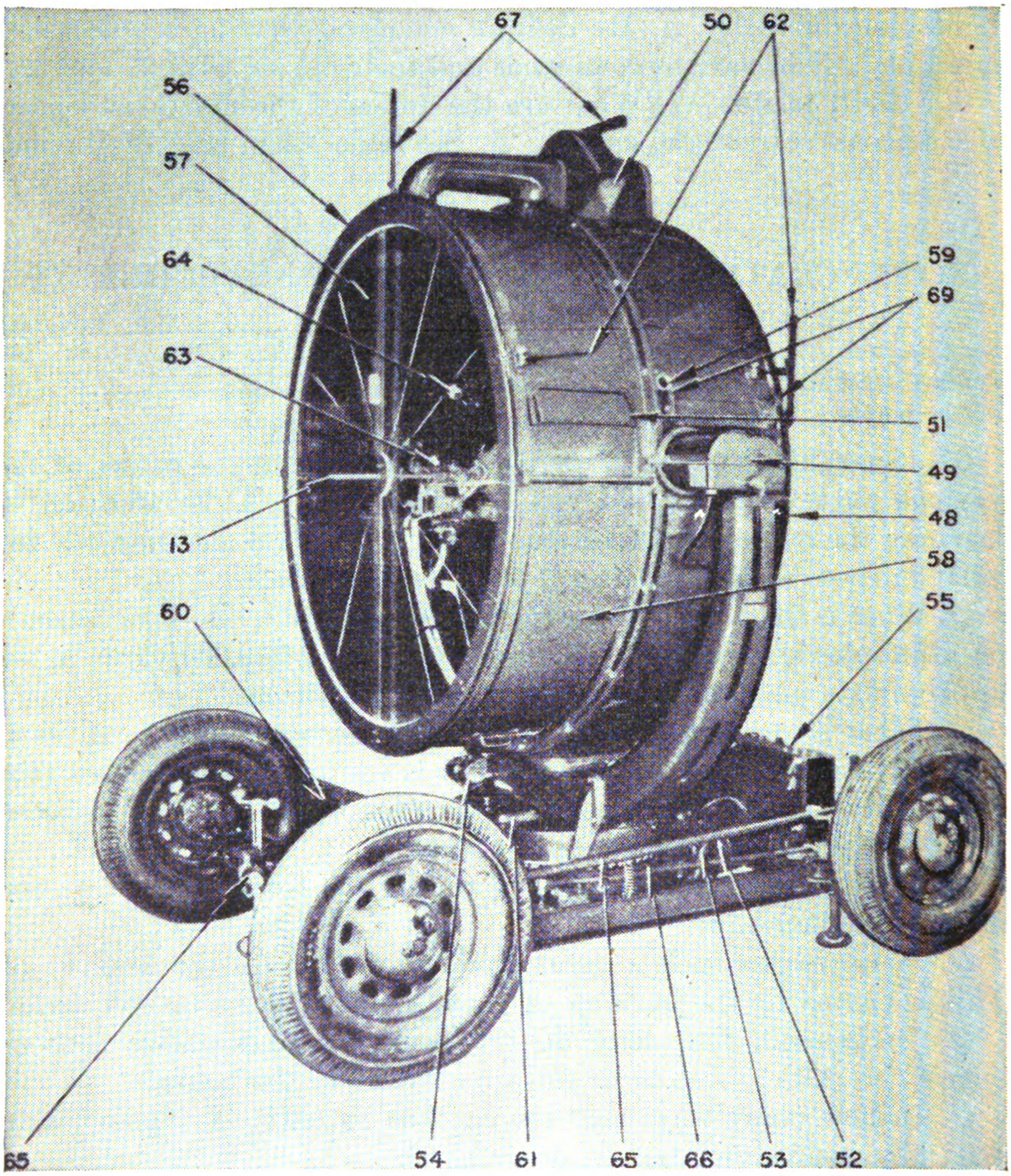


FIGURE 82.—Sperry M1941 antiaircraft searchlight (front quarter view).

b. *Sperry searchlights*.—*Q*. Point out the various parts of the searchlight with which your unit is equipped. While pointing out each part describe its use. *A*. See figures 82 to 85, inclusive.

NOTE.—All Sperry searchlights are similar except as noted under columns headed "Part" and "Purpose or use."

Part	Purpose or use
13. Positive carbon	When burning, light comes from incandescent gas which forms in the positive crater.
48. Rear drum	Made of aluminum alloy, it houses and supports the metal mirror and the arc lamp column on which is mounted the lamp unit.
49. Elevation data receiver housing. (Not part of M1934 and M-VI lights. M-VI light has a transmitter instead of a receiver at this location.)	It houses the elevation data receiver which is connected electrically by cable to the sound locator elevation data transmitter. The receiver causes the elevation "zero readers" (one at the searchlight and one at the control station) to indicate elevation data. (For the M-VI light only: The transmitter sends data to the comparator giving the position of the light.)
50. Ventilating motor and exhaust vent.	This motor causes fresh air to be drawn into the drum, and it exhausts burnt gases from the arc through the exhaust vent.
51. Ventilating fan intake vents.	Fresh air enters the drum at five intake vents.
52. Azimuth control motor	This motor causes the searchlight to rotate in azimuth and is controlled by the azimuth distant electric control handwheels at the control station. (For the M-VI light only: A control switch for this motor is mounted under main power receptacles.)
53. Azimuth motor clutch lever	When clutch lever is in the "out" position, the shaft of the azimuth control motor is disconnected. When the clutch lever is "in," the azimuth control motor shaft is connected to the searchlight ring gear and can turn the light in azimuth.
54. Azimuth scale lamp	To furnish illumination so azimuth scale may be set to correct azimuth when orienting.
55. Junction box	All cables are connected to the junction box, and wiring goes out of the junction box to connect the proper circuit.
56. Front drum	Made of sheet duralumin, it is bolted to the rear drum, and supports the front door.
57. Glass door	This glass protects the arc from wind and rain. The 12-segment construction makes it shockproof.
58. Sliding panel	There are two sliding panels, one on seach side of the front drum, to permit access to the interior of the drum for maintenance and recarboning.
59. Arc view peep sight	To observe the condition and position of the arc.
60. Ballast resistor	Encased in a housing, this resistor is in the arc circuit to give the arc stability so it will not sputter. *Never adjust this resistor except under direction of an electrician sergeant or an officer.*
61. Handhold plate	Permits access into the base to inspect brushes and slip rings which form a part of various circuits, including the main arc circuit.
62. Elevation daylight sights	These are provided so that the error in pointing the searchlight in elevation may be determined. The sights are graduated in mils.
63. Lamp unit	Mechanism for supporting and feeding the carbons.
64. Recarboning lamp	To give illumination inside the drum when recarboning the lamp at night.
65. Steering tongue and lug	For steering the searchlight.
66. Transportation bar	To lock the searchlight drum in its traveling position.
67. Azimuth daylight sights	These are provided so that the error in pointing the searchlight at the target in azimuth may be determined.
69. Orienting sights	For use in orienting the searchlight with sound locator. (On earlier models than the M1941, the orienting sights are mounted on the *right side* of the drum.)

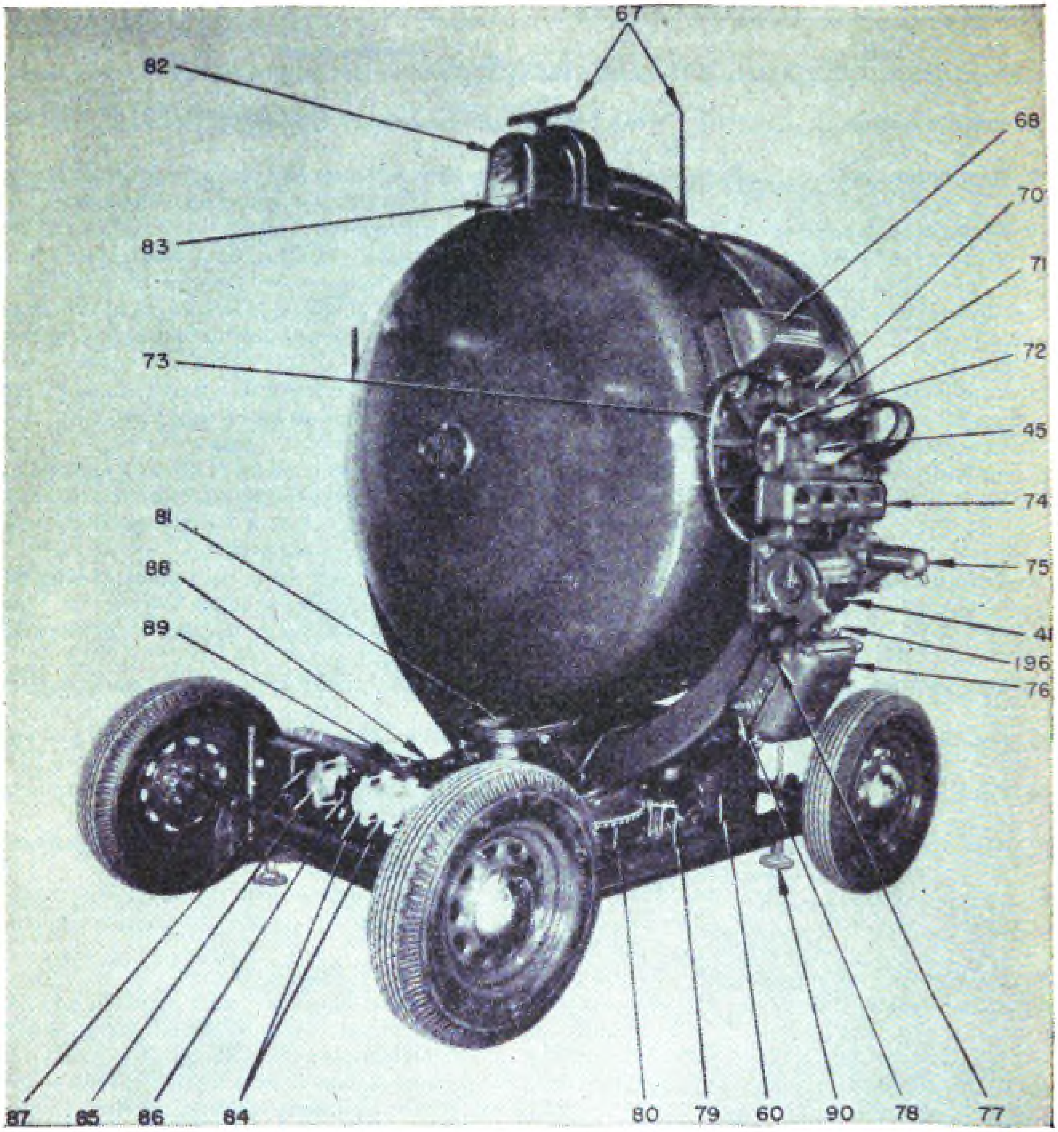


FIGURE 83.—Sperry M1941 antiaircraft searchlight (rear quarter view).

Part	Purpose or use
41. Elevation control motor	This motor causes the searchlight to elevate or depress and is controlled by the elevation distant electric control handwheels at the control station. (For the M-VI light only: A control switch for this motor is mounted on the right trunnion arm.)
45. Arc view peep sight	To observe the condition and position of the arc.
60. Ballast resistor	Encased in a housing, this resistor is in the arc circuit to give the arc stability so it will not sputter. *Never adjust this resistor except under direction of an electrician sergeant or an officer.*

Part	Purpose or use
67. Azimuth daylight sights	These are provided so that the error in pointing the searchlight in azimuth may be determined.
68. Lamp control mechanism box	This box houses the mechanism which automatically feeds the carbons so that the arc operates at a voltage of 78 volts and a current of 150 amperes.
70. Recarboning lamp switch	Turns on the recarboning lamp. The scale and meter light switch must be "on" also, except on the M-VI light.
71. Elevation scale lamp	To illuminate the elevation scale when orienting.
72. Elevation scale	It is used for orienting and pointing the light in elevation.
73. Elevation gear sector	The elevation control motor and the elevation extended hand control are geared to this gear sector so that the light may be elevated or depressed.
74. Meter box	It contains an azimuth zero reader, an elevation zero reader, an ammeter for checking the arc current, and a voltmeter for checking the arc voltage. (For the M1937 light only: The elevation zero reader is mounted near the left trunnion on its receiver, the azimuth zero reader on the base of the light near its receiver.) (For the M-VI and M1934 lights only: There are no zero readers on these lights.)
75. Hand controller socket	The extended hand controller fits into this socket.
76. Arc switch box	This box houses the arc switch.
77. Extension lamp receptacle	A trouble lamp extension cord is connected to this receptacle.
78. Scale and meter light switch	Lights lamps so that the meter box instruments can be seen, and also turns on the azimuth and elevation scale lamps.
79. Azimuth lock	Locks searchlight in azimuth traveling position.
80. Azimuth scale	For orienting the searchlight in azimuth.
81. Azimuth data receiver housing. (Not part of M1934 and M-VI lights. M-VI light has a transmitter instead of a receiver at this location.)	It houses the azimuth data receiver which is connected electrically by cable to the sound locator azimuth data transmitter. The receiver causes the azimuth zero readers (one at the searchlight and one at the control station) to indicate azimuth data. (For the M-VI light only: The transmitter sends data to the comparator giving the light position.)
82. Ventilating motor housing	Houses ventilating motor and fan.
83. Transportation lock bar lug	The transportation bar is locked to this lug so that the drum can be locked in its traveling position.
84. Power cable receptacles	Painted yellow. The yellow positive and negative power cables are connected here.
85. Control station cable receptacle	Painted red. The red cable from the control station is connected here.
86. Sound locator cable receptacle. (Not part of the M-VI and M1934 lights since this cable goes to comparator directly on these models. The M-VI light has a white receptacle and a green receptacle at this location.)	Painted blue. The blue cable from the sound locator connects to this receptacle. (For the M-VI light only: The white cable for sending searchlight position data to the comparator connects to the white receptacle. The green cable for delivering 110 volts alternating current for the a-c data transmission system connects the green receptacle to the power unit.)
87. Signal buzzer. (Not part of the M-VI or M1934 lights.)	The buzzer switchbutton at the control station is closed when the searchlight is to be put "in action."
88. Dynamotor (behind wheel). (For the M-VI light it is located at the power plant. For the M1934 unit it is located at the control station.)	This is a motor generator. The motor operates at line voltage, driving the generator which generates 110-volt alternating current to operate the data transmission system.
89. Dynamotor pilot light	A red light indicates that there is alternating current power for the data transmission system.
90. Leveling jacks	For leveling the searchlight. Two levels are provided on the base of the searchlight for this purpose.
196. Recarboning safety swtich. (Found only on the M1941 light.)	*Switch must be thrown to "recarboning" position before entering drum, otherwise a person may be killed.*

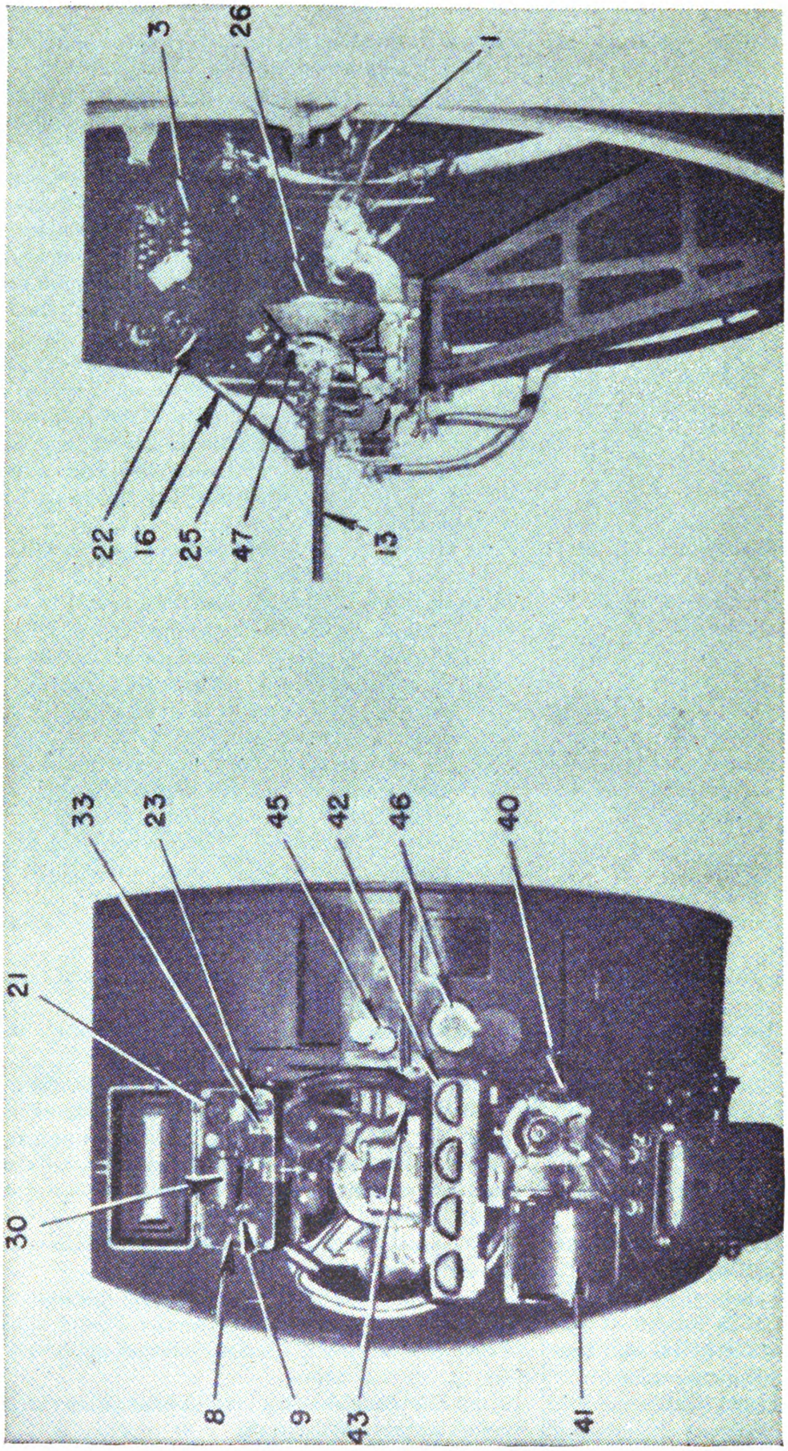


FIGURE 84.—Lamp and lamp control mechanism, Sperry M1941 searchlight.

Part	Purpose or use
1. Negative carbon	Direct current passing through this carbon and the positive carbon forms the arc of the searchlight.
3. Negative control rod	This rod rotates so as to feed the negative carbon forward or backward.
8. Negative hand feed knob	Turning this knob by hand turns the negative control rod and feeds the negative carbon. Keep voltmeter voltage at 78 volts by turning this knob when using hand feed.
9. Negative feed centralizer lever	When this lever is moved to its "auto" position, the negative carbon feeds automatically. When moved to "hand" position, the negative carbon must be fed by hand. (See part 8 above.)
13. Positive carbon	When the arc is operating, the positive carbon burns, causing incandescent gas to form a "positive crater." From this crater comes the brilliant light for the beam.
16. Positive control rod	This rod rotates counterclockwise so that the positive carbon may be fed forward and then rotated to cause the positive crater to burn evenly.
21. Positive hand feed handwheel	Rotating this handwheel counterclockwise rotates the positive control rod so as to feed and rotate the positive carbon.
23. Positive feed rate adjustment screw.	Adjust this screw so that the "normal rate of feed" (one "click") is *slightly less* than the rate of burning of the positive carbon. This "normal rate of feed" allows the positive carbon to burn back slowly so that the thermostat may act to keep the positive crater at the focal point of the metal mirror.
25. Thermostat	When the positive carbon burns back, the positive crater moves away from the focal point of the mirror. This cause rays of light to be focused on a bimetallic strip which is warped by the heat from the light rays. When the bimetallic strip warps, it closes a circuit which automatically causes the positive carbon to feed forward to the focal point of the mirror.
26. Thermostat lens	This lens focuses rays of light so as to cause the thermostat to operate.
30. Feed motor	This motor activates the feed mechanism so that the positive and negative carbons may be fed automatically.
33. Arc length adjustment screw	In automatic operation, this screw is adjusted so that the arc voltage is 78 volts as read on the voltmeter.
40. Elevation control clutch lever	With this clutch in the "D. E. C." position, the searchlight is elevated or depressed by distant electric control. With the clutch in the "hand" position, the extended hand controller is used to elevate or depress the searchlight.
41. Elevation control motor	See description of part 41, figure 83.
42. Focusing knob (behind meter box).	Turning this knob moves the lamp unit back and forth on the arc lamp column. By this means the positive crater is moved to the focal point of the mirror.
43. Thermostat adjusting screw	This screw adjusts the distance between the contacts of the thermostat bimetallic switch.
45. Peep sight	To observe the condition and position of the arc.
46. Ground glass finder	This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black or focal line. *Never allow the positive carbon to burn back beyond the red danger line.*
47. Focusing rod	This rod rotates when the focusing knob is turned, and moves the lamp unit.

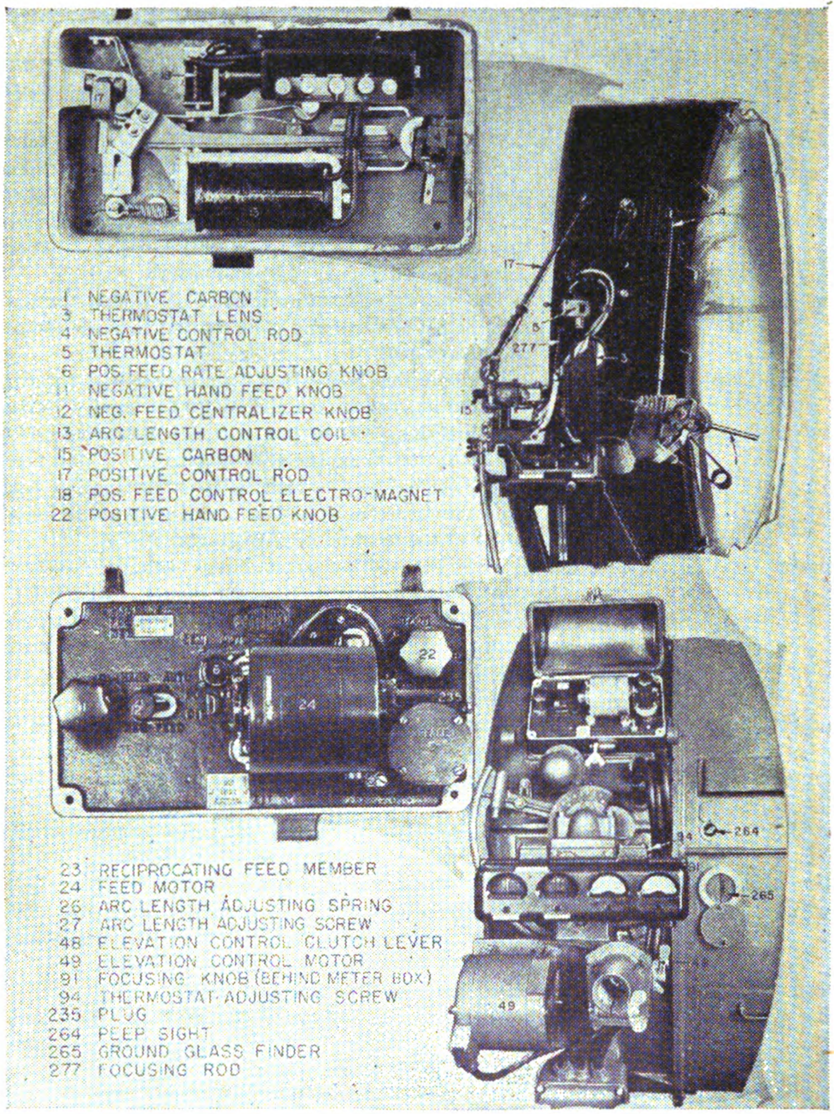


FIGURE 85.—The lamp and lamp control mechanism, Sperry M1934 searchlight.

NOTE.—The nomenclature of the M–VI, M1937, M1939, and M1940 Sperry lights is the same as that of the M1934 light.

Part	Purpose or use
1. Negative carbon	Direct current passing through this carbon and the positive carbon forms the arc of the searchlight.
3. Thermostat lens	This lens focuses rays of light on the thermostat bimetallic strip.
4. Negative control rod	This rod rotates so as to feed the negative carbon forward or backward.
5. Thermostat	When the positive carbon burns back, the positive crater moves away from the focal point of the mirror. This causes rays of light to be focused on a bimetallic strip which is warped by the heat from the light rays. When the bimetallic strip warps, it closes a circuit which automatically causes the positive carbon to feed forward to the focal point of the mirror.
6. Positive feed rate adjusting knob	Adjust this knob so that the "normal rate of feed" (one "click") is *slightly less* than the rate of burning of the positive carbon. This "normal rate of feed" allows the positive carbon to burn back slowly so that the thermostat may act to keep the positive crater at the focal point of the metal mirror.
11. Negative hand feed knob	Turning this knob by hand turns the negative control rod and feeds the negative carbon. Keep voltmeter voltage at 78 volts by turning this knob when using hand feed.
12. Negative feed centralizer knob	When this knob is moved to its "auto" position, the negative carbon feeds automatically. When moved to "hand" position, the negative carbon must be fed by hand.
13. Arc length control coil	This coil acts as a magnet and positions an armature which causes the negative carbon to feed so as to keep the arc length constant.
15. Positive carbon	When the arc is operating, the positive carbon burns, causing incandescent gas to form a "positive crater." From this crater comes the brilliant light for the beam.
17. Positive control rod	This rod rotates counterclockwise so that the positive carbon may be fed forward and then rotated to cause the positive crater to burn evenly.
18. Positive feed control electromagnet.	This magnet is energized when the thermostat operates. It pulls up a guard so that the positive carbon may be fed forward faster.
22. Positive hand feed knob	Rotating this knob counterclockwise rotates the positive control rod so as to feed and rotate the positive carbon.
23. Reciprocating feed member	The part is moved back and forth by the feed motor and causes the positive and negative carbons to be fed.
24. Feed motor	This motor is the source of power for operating the feed mechanism.
26. Arc length adjusting spring	This holds the armature in its correct position against the pull of the arc length control coil.
27. Arc length adjusting screw	It adjusts the arc length adjusting spring so as to keep the arc voltage at 78 volts as read on voltmeter.
48. Elevation control clutch lever	With this clutch in the "D.E.C." position, the searchlight is elevated or depressed by distant electric control. With the clutch in the "hand" position, the extended hand controller is used to elevate or depress the searchlight.
49. Elevation control motor	Causes light to be elevated or depressed. It is controlled by the elevation operator at the control station.
91. Focusing knob (behind meter box).	Turning this knob moves the lamp unit back and forth on the arc lamp column. By this means the positive crater is moved to the focal point of the mirror.
94. Thermostat adjusting screw	This screw adjusts the distance between the contacts of the thermostat bimetallic switch.
235. Plug	Removal of this plug provides access to the feed motor shaft.

c. General Electric searchlight M1940.—*Q*. Point out the various parts of the General Electric searchlight M1940. *A*. See figure 86 to 89, inclusive.

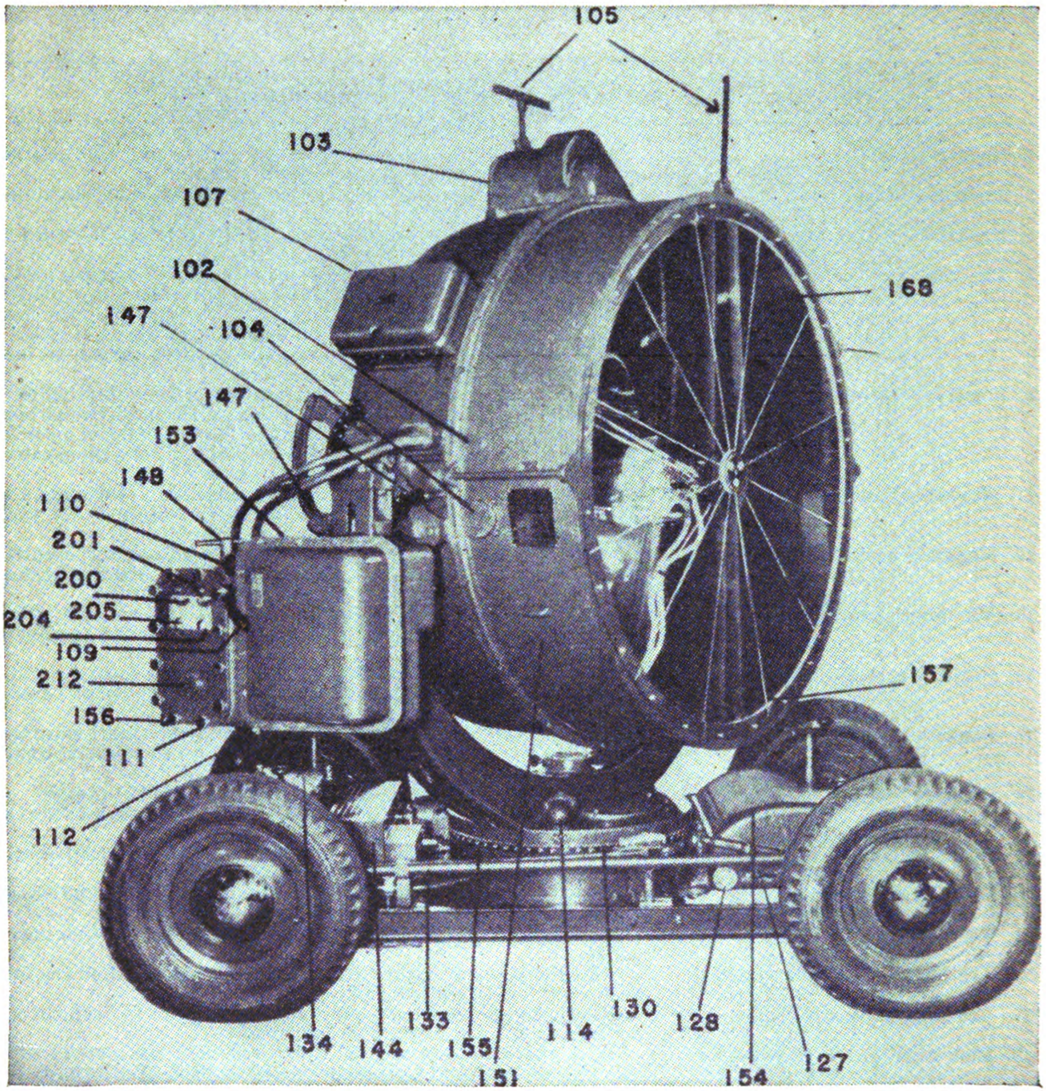


FIGURE 86.—General Electric M1940 searchlight (front quarter view).

Part	Purpose or use
102. Arc viewing window	To observe the position and condition of the arc.
103. Ventilating fan motor housing	This houses the ventilating fan which exhausts the burned gases from the drum interior.
104. Arc image screen	This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black focal line. *Never allow the positive carbon to burn back beyond the red danger line.*

Part	Purpose or use
105. Azimuth daylight sights	For use in training. Platoon commander may check in azimuth while a target is being tracked, thus observing any error.
107. Lamp control mechanism box	Within this box are located the various mechanisms for feeding the positive and negative carbons.
109. Elevation brake handle	For locking the searchlight at any desired elevation.
110. Extended hand control bar socket.	The extended hand control bar fits in this socket so light may be moved by hand in elevation and azimuth.
111. Recarboning lamp switch	Light is turned on inside the drum during recarboning.
112. Scale lamp switch	This switch turns on meter, elevation scale, and azimuth scale lamps.
114. Azimuth scale lamp	To illuminate azimuth scale.
127. Azimuth clutch handle	This disconnects the azimuth D. E. C. training motor when traversing by hand.
128. Dynamotor switch	This turns on the dynamotor which converts direct current into alternating current for use in the data transmission system and for the D. E. C. system.
130. Elevation stowing rod	The searchlight drum is elevated and locked in this position by means of the stowing rod when the light is put in traveling position.
133. Towing bar	For steering the light and for towing by hand for short distances.
134. Junction box	All cables are connected to the junction box, from which place connections are made to the proper circuits.
144. Ballast resistor	This resistor is in the arc circuit. *Never change this connection except under the direct supervision of an electrical sergeant or an officer.*
147. Focusing knob	By turning this knob the lamp may be moved so that positive crater is at the focal point of mirror.
148. Extended hand control bar clamp.	This clamps the extended hand control bar in the socket.
149. Elevation scale lamp	For illuminating the elevation scale.
151. Drum access door	For entering drum for recarboning, or other purpose.
153. Elevation control box	Within this box is the D. E. C. elevation training motor and its auxiliary equipment.
154. Azimuth control box	Within this box is the D. E. C. azimuth training motor and its auxiliary equipment.
155. Azimuth scale	This scale is used when orienting the searchlight. It may be slipped around for proper setting.
156. Arc switch handle	This switch when "closed" allows the arc to form and a current to flow through it.
157. Counterweight	This helps to balance the searchlight on its trunnions.
168. Glass door	This glass protects the arc from wind and rain. The 12-segment construction makes it shockproof.
200. Azimuth zero reader	This is a voltmeter which has a pointer at the center of its scale. When new sound locater azimuth data are received this pointer moves away from its center (or zero) position.
201. Elevation zero reader	This is a voltmeter with a pointer at the center (or zero) of its scale. When new sound locator elevation data are received the pointer moves away from its center (or zero) position.
204. Arc ammeter	This ammeter indicates the amount of current flowing through the arc. It should read 150 amperes when the arc is operating properly.
205. Arc voltmeter	The voltmeter indicates the voltage drop across the arc. It should read 78 volts when the arc is functioning properly.
212. Dynamotor a-c indicating lamp	A red lamp glows when the dynamotor is operating.

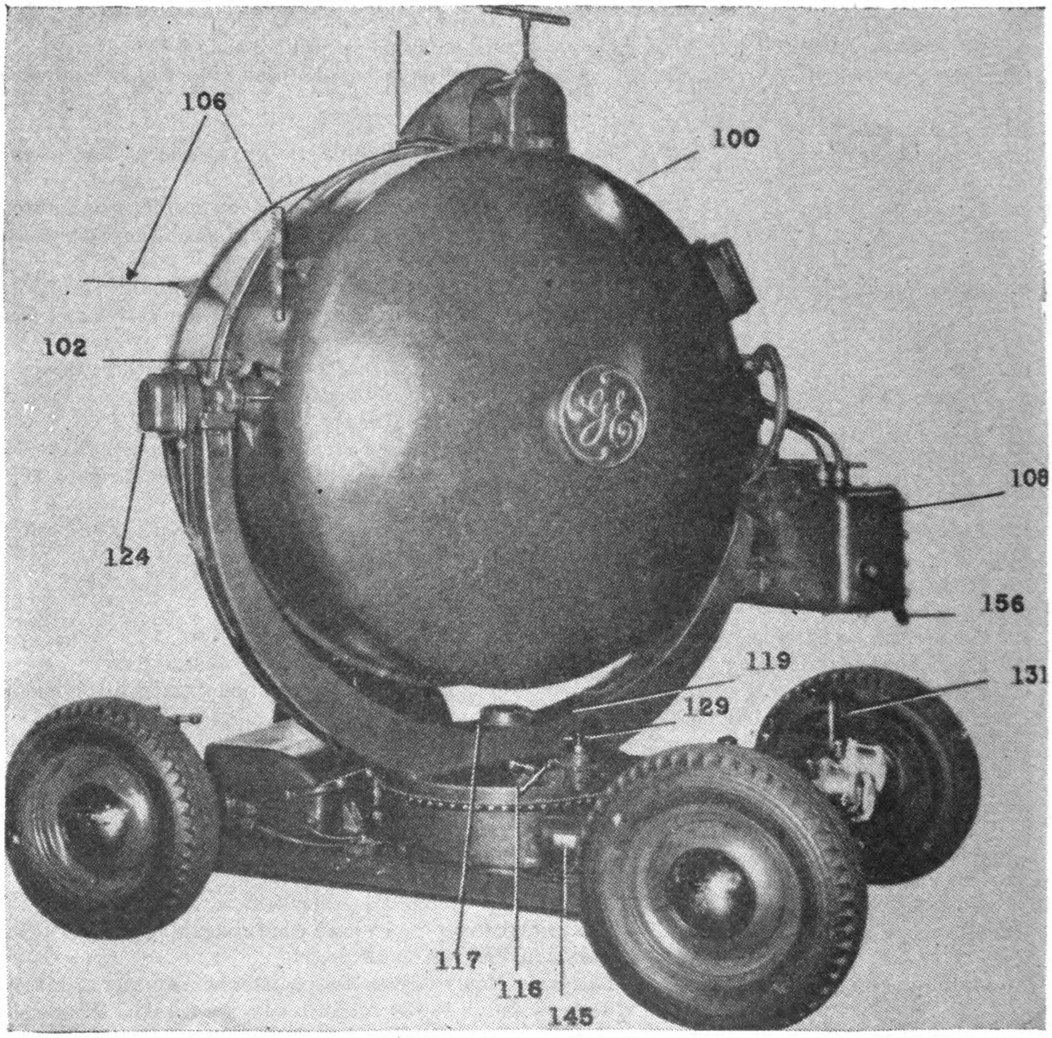


FIGURE 87.—General Electric M1940 searchlight (rear quarter view).

Part	Purpose or use
100. Drum	The drum contains the metal mirror and supports the lamp, lamp feed mechanism, and the ventilating system.
102. Arc viewing window	To observe the position and condition of the arc.
106. Elevation daylight sights	For use in training. Platoon commander can check in elevation while a target is being tracked, thus observing any error.
108. Elevation clutch handle	When this handle is in the hand control position the searchlight may be elevated by hand.
116. Levels	To level the searchlight.
117. Spindle cover	For access to the spindle and azimuth data receiver.
119. Azimuth correction knob	For use when sychronizing the azimuth zero reader system.
124. Elevation data receiver cover	This cover must be taken off to sychronize the elevation zero reader system.
129. Azimuth stowing lock	When putting the searchlight in traveling position this locks the searchlight in azimuth.
131. Leveling jacks	For leveling the searchlight.
145. Dynamotor	Converts direct current to alternating current which is used by the data transmission system and the D. E. C. system.
156. Arc switch handle	Closing this switch permits the arc to start.

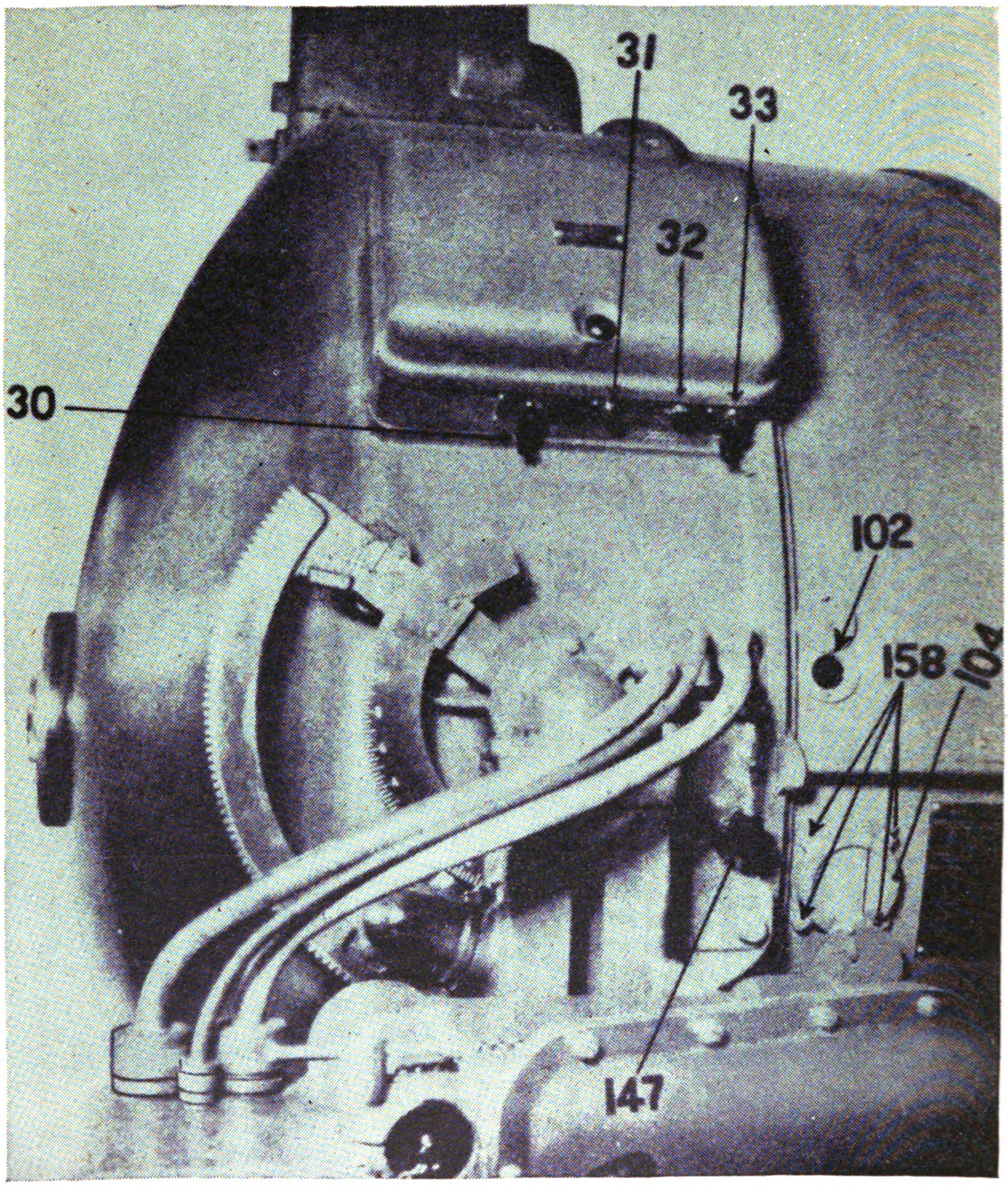


FIGURE 88.—General Electric M1940 searchlight (right upper view).

Part	Purpose or use
30. Negative carbon manual drive crank.	By pushing this crank "in," the negative carbon may be fed by hand instead of automatically.
31. Positive carbon feed button	Push button "in" to feed positive carbon faster. In hand operation it is worked in conjunction with part 33.
32. Positive carbon feed rate adjustment knob.	Turning this knob clockwise causes the positive carbon to feed faster.
33. Positive carbon manual drive crank.	Push in crank and turn in clockwise direction to rotate positive carbon. In hand feed it is worked in conjunction with part 31.
102. Arc viewing window	To observe the condition and position of the arc.
104. Arc image screen	This is used to check accurately the position of the positive crater. The end of the positive carbon should terminate at the black focal line. *Never allow the positive carbon to burn back beyond the red danger line.*
147. Focusing knob	By turning this knob the lamp assembly is moved so that the positive crater is placed at the focal point of the mirror.
158. Arc image adjusting screws	These are for making a correct adjustment of the positive carbon on the image screen *by the searchlight commander.*

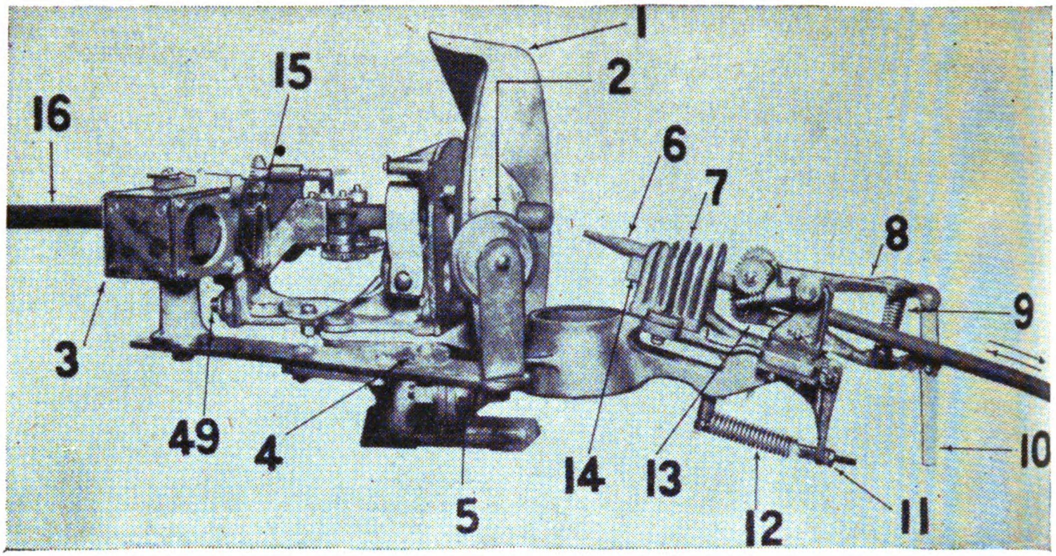


FIGURE 89.—Lamp and lamp control mechanism, General Electric M1940 searchlight.

Part	Purpose or use
1. Obturator	This is a bronze casting to protect the positive head from excessive heat. It also prevents stray light.
2. Thermostat mirror	This mirror reflects rays of light from the positive crater onto the thermostat.
3. Thermostat	When the positive carbon burns back too far, rays of light heat up the thermostat bimetallic strip which closes a circuit. This causes the positive carbon to feed forward to its proper position.
4. Positive carbon protrusion adjusting nut.	This adjustment positions the thermostat mirror which, through the thermostat, keeps the positive carbon at its proper position, ¾ of an inch from positive nose.
5. Negative head mounting bolts	Holds negative head to lamp base.
6. Negative carbon	Direct current passing through this carbon and the positive carbon forms the arc of the searchlight.
7. Negative nose	Bronze casting for holding negative carbon.
8. Movable drive roller bracket	On this bracket are mounted the upper negative feed rollers.
9. Negative carbon drive pressure spring.	This spring causes the negative feed rollers to make good contact with the negative carbon.
10. Negative carbon drive roller clamp.	Pushing this clamp to the left lifts the movable drive roller bracket so that a new negative carbon may be inserted.
11. Negative carbon brush pressure adjusting nut.	Screwing the adjusting nut farther up causes more pressure to be applied by negative brush 14 on negative carbon 6.
12. Negative carbon brush pressure spring.	This spring exerts the force which causes a pressure of the negative brush on the negative carbon.
13. Adjustable drive roller bracket.	On this adjustable bracket are mounted the lower negative feed rollers.
14. Negative brush	This brush makes a good contact with the negative carbon so current may flow through it more easily.
15. Positive carbon feed roller clamp.	This clamp is used when renewing the positive carbon. It separates the positive feed rollers.
16. Positive carbon	When the arc is operating, the positive carbon burns, causing incandescent gas to form a positive crater. From this crater comes the brilliant light for the beam.
49. Positive head mounting bolt	This holds the positive head to the lamp base.

62. Control stations.—*a. General.*—*Q.* Why is a control station necessary? *A.* To obtain the best "contrast" the operator must be at least 50 feet away from the searchlight beam. At this distance an electrical remote control system must be used to point the searchlight in azimuth and elevation. The control station is a part of this remote control system, and from this station the searchlight may be pointed in azimuth and elevation.

Q. What is meant by "contrast"? *A.* "Contrast" means the difference between the amount of light reflected from the target and the amount of light reflected from the illuminated sky background. The greater the contrast the better the target can be seen in the beam.

b. Sperry control stations.—*Q.* In addition to being able to control the searchlight from a remote point, what other function must the control station perform? *A.* It must give an indication of sound locator data so that the searchlight may be pointed correctly. Also, the M1934 and later control stations have a means for searching 5° around sound locator data.

Q. How is "searching" accomplished on the Sperry control stations? *A.*

(1) *M1939, M1940, and M1941 control stations only.*—Each zero reader has three graduations on its face; a center index, and a graduation on either side of the index. Using the zero reader handwheel to move the pointer *slowly* between the outer graduations will cause the searchlight to search 5° around sound locator data.

(2) *M1937 control station only.*—Pushing in the search control knob (located to the right of the azimuth zero reader) causes an electric motor to drive an oscillating mechanism, which causes an automatic oscillation in elevation of 5° around sound locator data. Rotating the search control knob slowly offsets the azimuth zero reader pointer which, when brought back to its center position, causes a 5° search in azimuth around sound locator data.

(3) *M1934 control station only.*—An automatic spiral searching device, which causes a search in both azimuth and elevation of 5° around sound locator data, is controlled by a handwheel placed directly under the binocular mount. When the handwheel is rotated *slowly* the searchlight searches 5° around sound locator data.

Q. Name and give the functions of the various parts of the control station with which your organization is equipped. *A.* See figures 90 to 93, inclusive.

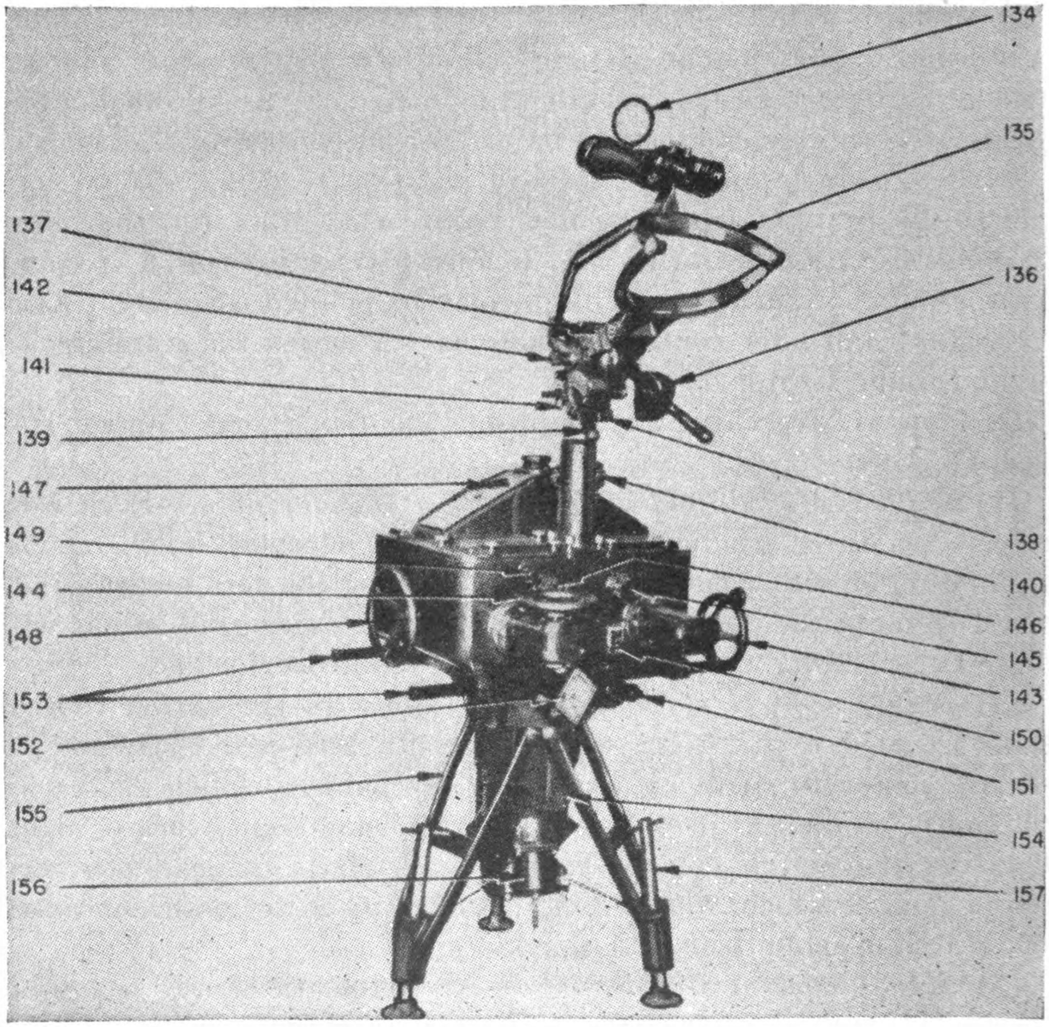


FIGURE 90.—Sperry control station M1941 (binocular mount in position).

NOTE.—The nomenclature of the M1937, M1939, and M1940 Sperry control stations is the same as the M1941 control station.

Part	Purpose or use
134. Open sight	For getting approximately on a target and for orienting the control station.
135. Binocular mount	Supports binoculars. This mount is geared to the elevation zero reader handwheel so that binoculars may be pointed in elevation according to sound locator data. It moves in azimuth as the control unit moves.
136. Binocular mount counter weights.	To balance the binoculars.
137. Binocular elevation zero marker	To establish zero elevation when orienting the control station.
138. Binocular azimuth zero marker	To establish the correct azimuth when orienting the control station.
139. Binocular mount adjustment handles.	By grasping these handles the binocular mount can be moved in azimuth and elevation. They are used especially to put the binocular line of sight on the searchlight beam in case the beam is not seen in the binoculars.
140. Binocular height adjusting knob	This knob allows adjustment of the binocular mount for individual height.
141. Binocular mount azimuth adjustment.	Tightening up on this adjusting nut tightens a spring friction disk so binocular mount does not move too easily in azimuth.
142. Binocular mount clutch adjustment.	This adjusting screw must be adjusted so that binocular mount does not move too easily in elevation.
143. Observer's elevation handwheel	The observer uses this handwheel to track in elevation after the target is flicked.
144. Observer's azimuth handwheel	The observer uses this handwheel to track in azimuth after the target is flicked.
145. Elevation drive slip clutch	This clutch protects the elevation drive mechanism.
146. Azimuth drive slip clutch	This clutch protects the azimuth drive mechanism.
147. Azimuth zero reader	This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator azimuth data is received.
148. Azimuth zero reader handwheel	This handwheel rotates the control station and operates the azimuth D. E. C., which traverses the searchlight. This causes the pointer of the azimuth zero reader to move to its zero position when the searchlight is pointed according to sound locator azimuth data.
149. Signal buzzer push button	This is used to signal the searchlight to go "in action" or "out of action."
150. Zero reader light switch	The switch, when turned "on," lights the zero reader dials.
151. D-c switch	The switch must be turned "on" before the D. E. C. can be used.
152. Alinement lug	This lug fits in a notch machined in the control unit. The lug and notch must be lined up when putting control unit on tripod.
153. Carrying handles	Self-explanatory.
154. Handhole cover plate	Access may be had to the slip rings which electrically connect red cable to interior of control station.
155. Tripod	Supports control unit.
156. 15-point receptacle	Red cable plug from searchlight fits into this receptacle.
157. Leveling jack	Adjustment of these jacks permits leveling of the control station by means of spirit levels.

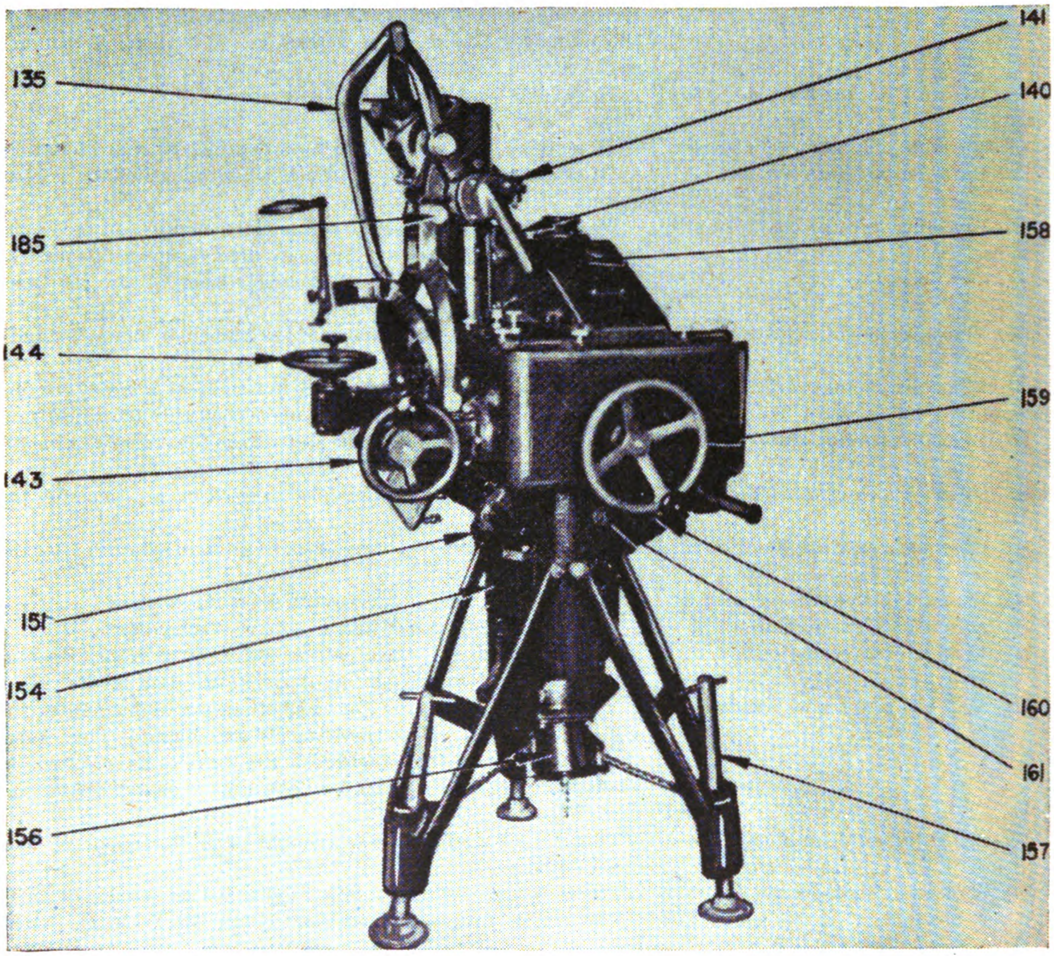


FIGURE 91.—Sperry M1941 control station (binocular mount folded down).

NOTE.—Nomenclature of the M1937, M1939, and M1940 control stations is the same as the M1941 control station.

Part	Purpose or use
135. Binocular mount	See figure 90.
140. Binocular height adjusting knob	See figure 90.
141. Binocular mount azimuth slip clutch.	See figure 90.
143. Observer's elevation handwheel	See figure 90
144. Observer's azimuth handwheel	See figure 90.
151. D-c switch	See figure 90.
154. Handhole cover plate	See figure 90.
156. 15-point cable receptacle	See figure 90
157. Leveling jacks	See figure 90.
158. Elevation zero reader	This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator elevation data are received.
159. Elevation zero reader handwheel	This handwheel elevates the binocular mount and operates the elevation D. E. C., which elevates the searchlight. This causes the pointer of the elevation zero reader to move to its zero position when the searchlight is pointed according to sound locator elevation data.
160. Spirit levels	These spirit levels are used to level the control station.
161. Clamp knob	Two knobs, on opposite sides of the control unit, lock the control unit to the tripod.
185. Binocular mount locking pin	This locks the binocular mount in its operating position so mount will move in elevation.

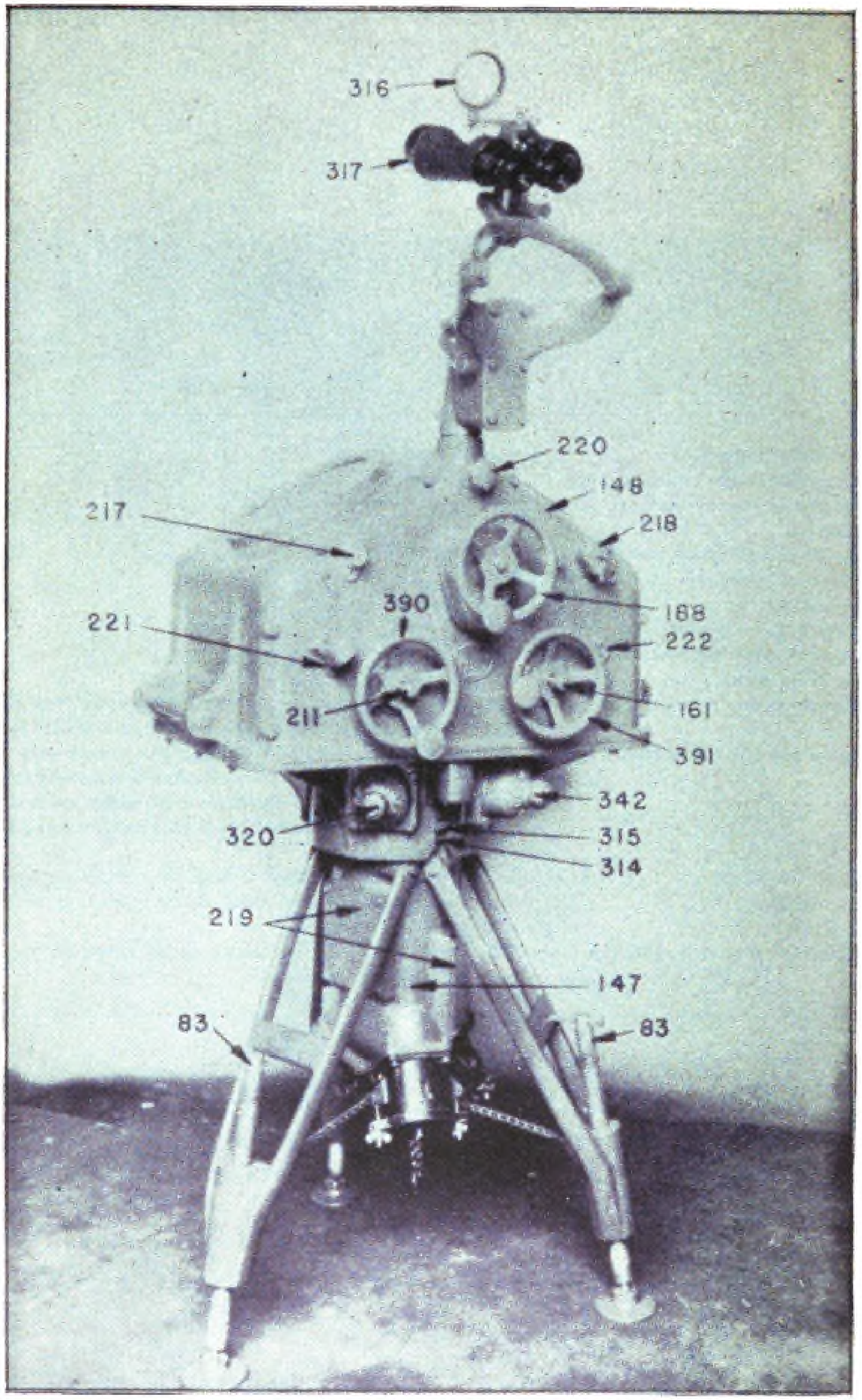


FIGURE 92.—Sperry control station M1934.

Part	Purpose or use
83. Leveling jacks	Adjustment of these jacks permits leveling of the control station by means of spirit levels.
147. Tripod	Supports control unit.
148. Control unit	This unit houses the D. E. C. and comparator mechanism.
161. Elevation handwheel clutch knob.	With clutch "in," the control station may be oriented and synchronized.
188. Searching handwheel	Rotation of this handwheel allows a search of 5° around sound locator data.
211. Azimuth handwheel clutch knob	This knob is pushed "in" when orienting and synchronizing.
217. Sound locator azimuth dial synchronizing knob.	This knob is used to sychronize the azimuth receiver with the sound locator azimuth transmitter.
218. Sound locator elevation dial synchronizing knob.	This knob is used to synchronize the elevation receiver with the sound locator elevation transmitter.
219. Handhole cover plates	Removal of these three plates provides access to the slip rings and brushes.
220. Binocular height adjusting knob	To adjust the binocular to any desired height.
221. Azimuth drive friction clutch adjustment screw.	Adjust this screw until a position is obtained at which the azimuth handwheel will slip if jerked.
222. Elevation drive friction clutch	Adjust this screw until a position is obtained at which the elevation handwheel will slip if jerked.
314. Alinement slot	This slot must engage a lug on the tripod when setting up the control station.
315. Alinement lug	See remark above.
316. Open sight	For approximately orienting the control station.
317. Binocular	For searching the searchlight beam.
320. A-c switch	This switch supplies a-c power for the data transmission system.
342. D-c switch	This switch supplies d-c power for the distant electric control (D. E. C.).
390. Observer's azimuth handwheel	The observer can control the searchlight in azimuth by means of this handwheel. To the shaft of this handwheel on the opposite side of the control unit is the azimuth follow-the-pointer handwheel.
391. Observer's elevation handwheel	The observer can control the searchlight in elevation by means of this handwheel. To the shaft of this handwheel, on the opposite side of the control unit, is attached the elevation follow-the-pointer handwheel.

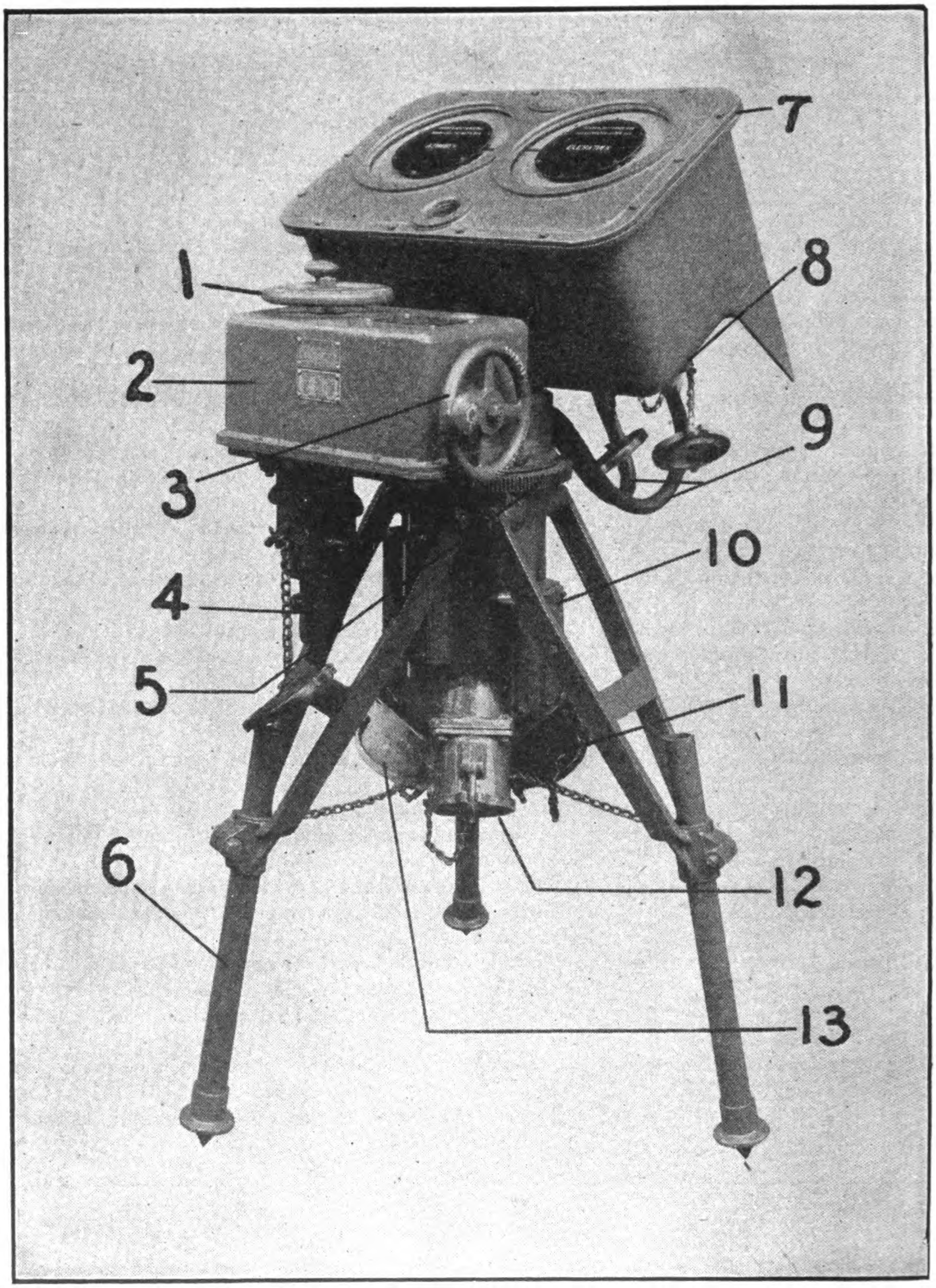


FIGURE 93.—Sperry M-VI control station.

Part	Purpose or use
1. Azimuth handwheel	This handwheel controls the searchlight in azimuth.
2. Searchlight controller	This houses the D. E. C. mechanism which causes the searchlight to be controlled remotely in azimuth and elevation from the control station.
3. Elevation handwheel	This handwheel controls the searchlight in elevation.
4. Cable from tripod to controller	The wire conductors for the electric circuits of the D. E. C. are contained in this cable.
5. Azimuth training gear	Movement of the azimuth handwheel causes the comparator and controller to rotate in azimuth about the tripod by means of this gear.
6. Tripod	The tripod supports the controller and comparator.
7. A-c comparator	This houses four a-c synchronous receivers. Two are connected through the blue cable to the sound locator, one for azimuth, the other for elevation. The other two are connected by the white cable to the searchlight, one for azimuth, the other for elevation. The azimuth operator causes the two azimuth pointers to be matched, while the elevation operator matches the two elevation pointers.
8. Synchronizing knob	For synchronizing the receivers with their respective transmitters.
9. Cables from tripod to comparator	Connects the four receivers to the white and blue cables.
10. Slip ring cover	Removing this cover provides access to the slip rings and brushes.
11. Receptacle for controller cable	Painted red. This cable connects the controller to the searchlight training motors.
12. Receptacle for sound locator cable	Painted blue. This cable connects the comparator sound locator data receivers to their respective transmitters at the sound locator.
13. Receptacle for searchlight cable	Painted white. This cable connects the comparator searchlight receivers to their respective transmitters at the searchlight.

c. General Electric control stations.—Q. In addition to being able to control the searchlight from a remote point, what other function must the General Electrc control station perform? *A.* It must give an indication of sound locator data so that the searchlight may be pointed correctly. Also, it has a means for searching 5° around sound locator data.

Q. Name and give the functions of the various parts of the General Electric control station M1940. *A*. See figures 94 and 95.

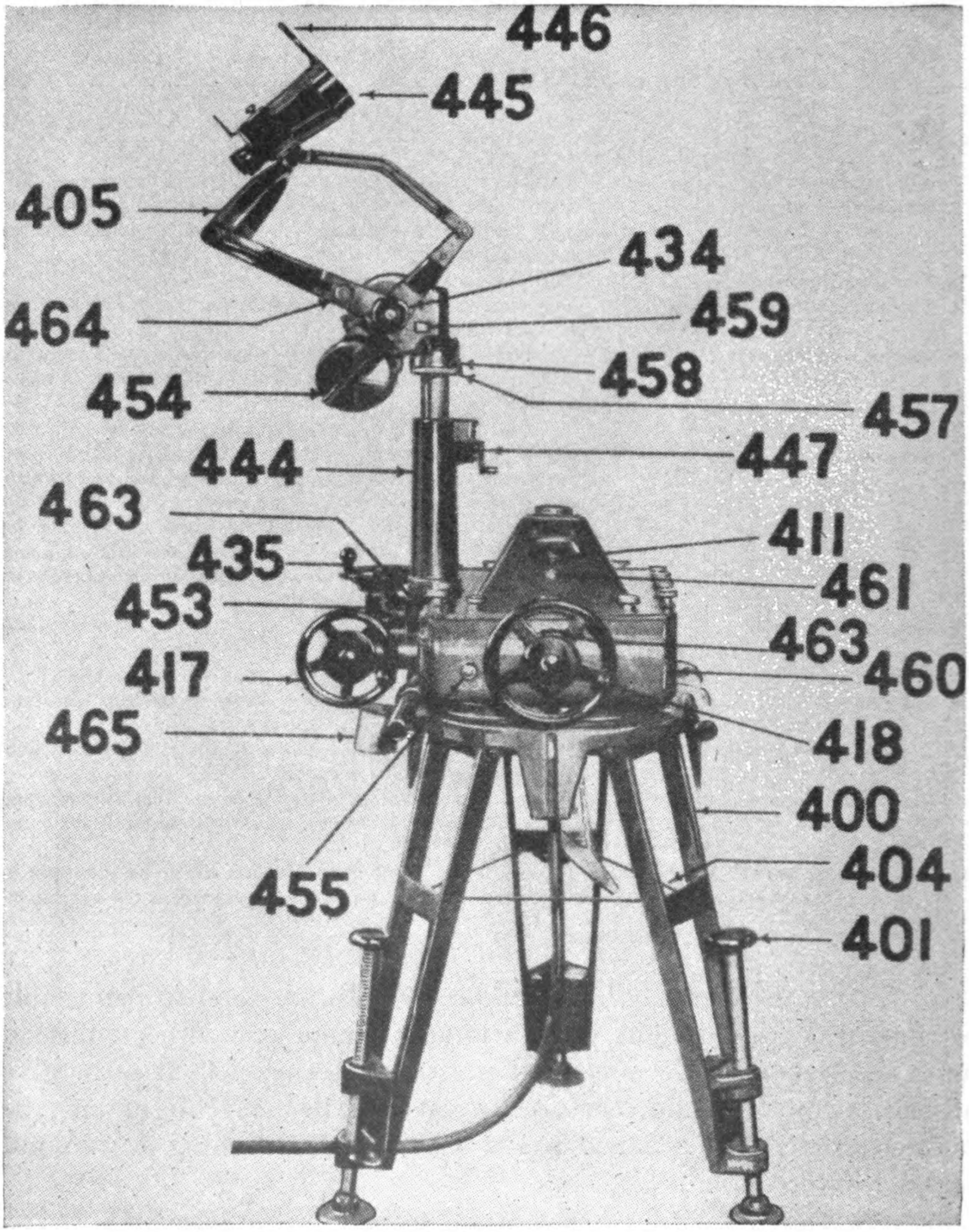


FIGURE 94.—General Electric M1940 control station (right side view).

Part	Purpose or use
400. Tripod	Controller is supported by this tripod.
401. Leveling jack	By adjusting the three jacks the control station may be leveled.
404. Tripod leg braces	To give rigidity to the tripod.
405. Binocular mount	Supports binoculars. This mount is geared to the elevation zero reader handwheel so that binoculars may be pointed in elevation according to sound locator data. It moves in azimuth as the controller moves.
411. Elevation zero indicator	This is a voltmeter whose pointer moves away from its center (zero) position as new sound locator elevation data are received.
417. Observer's elevation handwheel	The observer uses this handwheel to track in elevation after the target is flicked.
418. Elevation zero reader's handwheel.	This handwheel elevates the binocular mount and operates the elevation D. E. C., which elevates the searchlight. This causes the pointer of the elevation zero reader to move to its zero position when the searchlight is pointed according to sound locator elevation data.
434. Binocular linkage clamp	This clamp must be adjusted so that the elevation clutch does not allow the binocular mount to move too easily in elevation.
435. Observer's azimuth handwheel	The observer uses this handwheel to track in azimuth after target is flicked.
444. Binocular mount column	This column is a support for the binocular mount.
445. Binoculars	Self-explanatory.
446. Open sight	This is used when orienting the control station and for quickly getting on an illuminated target.
447. Binocular height adjusting crank	This allows adjustment of the height of the binocular for each individual.
453. Binocular column lock clamp	When binocular mount is lowered in column, it is locked by pushing in this lock clamp and turning clockwise.
454. Binocular positioning handles	By grasping these handles the binocular mount can be moved in azimuth and elevation. They are used especially to put the binocular line of sight on the searchlight beam in case the beam is not seen in the binoculars.
455. Signal switch	To signal searchlight to go "in action" or "out of action."
457. Binocular column azimuth friction adjusting nut.	This nut is adjusted so that the binocular mount does not move too easily in azimuth.
458. Azimuth reference mark	For use in orienting the control station in azimuth.
459. Horizontal reference mark	For use in orienting the control station in elevation.
460. Controller box	The controller box houses all the mechanisms and supports the binocular mount.
461. Elevation zero reader adjustment plug.	Loosen the plug and with a small screw driver turn voltmeter pointer adjusting screw until pointer is zeroed.
463. Level	To be used when leveling the control station.
464. Linkage pin	This pin must be in place so that the binocular mount operates properly.
465. Column socket cover	When binocular mount is disassembled this cover is screwed over the opening in the controller box.

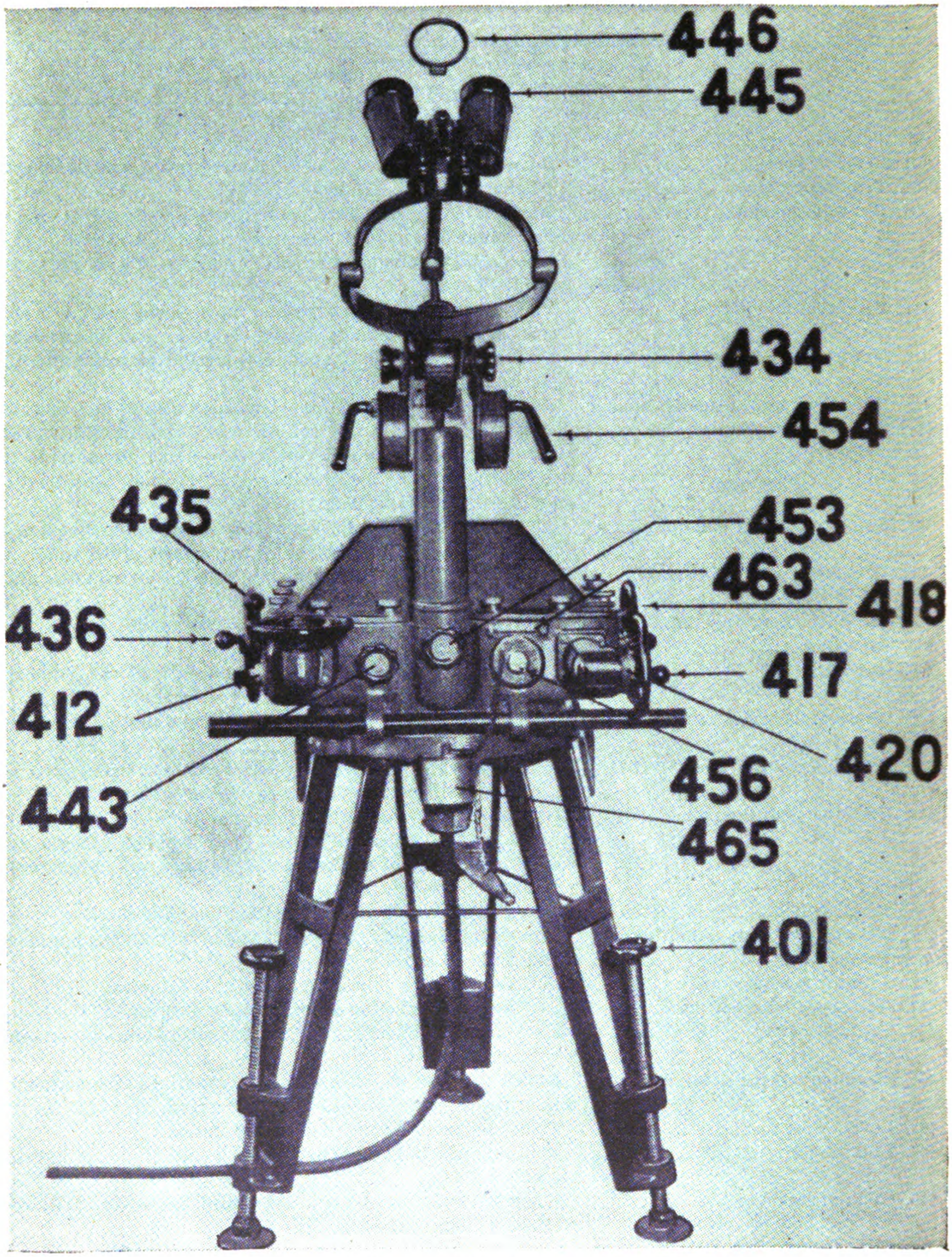


FIGURE 95.—General Electric M1940 control station (rear view).

Part	Purpose or use
401. Leveling jack	See reference to figure 94.
412. Scale lamp switch	To provide illumination for the zero readers.
417. Observer's elevation handwheel	See reference to figure 94.
418. Elevation zero reader's handwheel.	See reference to figure 94.
420. Handwheel friction clutch	To prevent damage to the elevation mechanism.
434. Binocular linkage clamp	See reference to figure 94.
435. Observer's azimuth handwheel	See reference to figure 94.
436. Azimuth zero reader's handwheel.	This handwheel rotates the controller in azimuth and operates the D. E. C., which traverses the searchlight. This causes the pointer of the azimuth zero reader to move to its zero position when the searchlight is pointed according to sound locator azimuth data.
443. Azimuth drive clutch knob	With this knob in its released position, the controller may be moved in azimuth when orienting, without moving the azimuth zero reader's handwheel.
445. Binoculars	Self-explanatory.
446. Open sight	See reference to figure 94.
453. Binocular column lock clamp	See reference to figure 94.
454. Binocular positioning handles	See reference to figure 94.
456. D. E. C. switch	This switch must be turned on before the D. E. C. will function.
463. Level	See reference to figure 94.

63. Power plants.—*a. Sperry power plants.*—*Q.* What difference is there between the M1941 Sperry power plant and previous Sperry power plants? *A.* There is very little difference between the Sperry M1941 power plant and the previous models. The rated speed of the engine varies but, in general, all models back to and including the portable M1934 power plant are very similar.

Q. What is the rated engine horsepower of the M1941 Sperry power plant? *A.* It is rated at 42 hp at 1,100 rpm.

Q. What is the generator rating of the M1941 Sperry power plant? *A.* The generator is rated as follows:

Volts	*Amperes*	*Rpm*	*Kilowatts*
100	162	1,100	16.2

Q. Is the power plant engine similar to an ordinary automobile engine? *A.* Yes. It has a self-starter, battery, battery charging generator, water-cooling system, ignition, choke, and other features of an ordinary automobile engine.

Q. Point out the various parts, by name, of the power plant with which your organization is equipped. *A.* See figures 96 and 97 for the M1941 Sperry power plant.

NOTE.—For the mobile M-VI, mobile M1934, portable M1934, M1937, M1939, and M1940 power units refer to the Operator's Manual furnished with these units, using examination questions and nomenclature corresponding to those used in this manual.

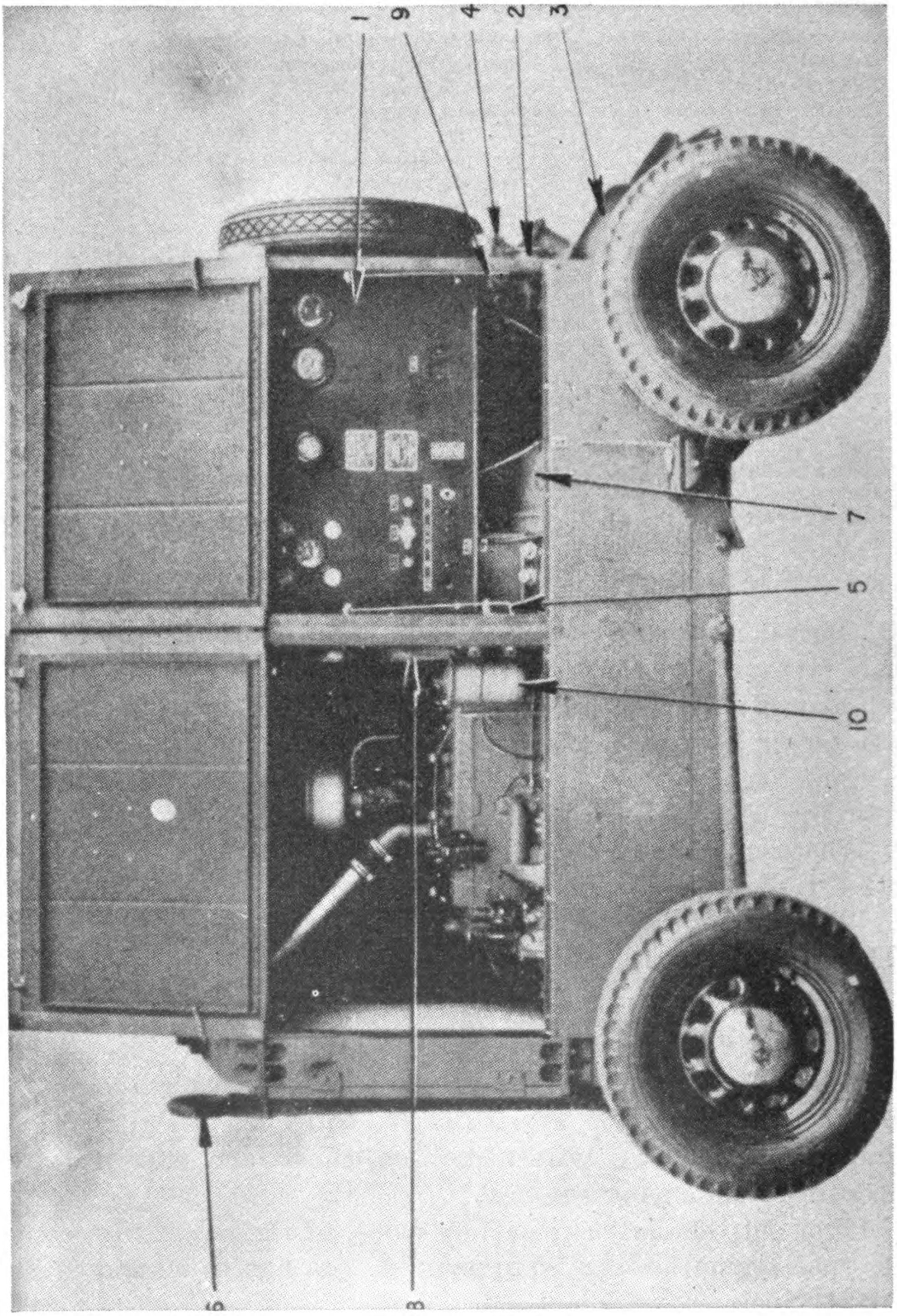


FIGURE 96.—Sperry M1941 power plant (left side).

Part	Purpose or use
1. Control panel	Contains all the necessary indicating instruments and equip ment for controlling and operating the unit.
2. Power receptacles	Provides a convenient means of attaching and removing the two power cables that transmit the electrical power from the power plant to the searchlight. One receptacle is for the positive cable, the other receptable for the negative cable.
3. Fuel tank	Gasoline supply for the engine. Capacity is 27½ gallons.
4. Tail lamp	Same purpose as tail lamp on automobile.
5. Control panel door bracket	Holds the control panel door in a horizontal position.
6. Tow bar	Used for towing and steering.
7. Power generator	A d-c compound wound generator which furnishes electrical power to operate the searchlight section.
8. Fan	Used for cooling the power plant. It is driven by a direct current ¾ hp motor.
9. Tail lamp switch	Turns tail lamp "on" or "off".
10. Oil filter	Filters the oil in the engine.

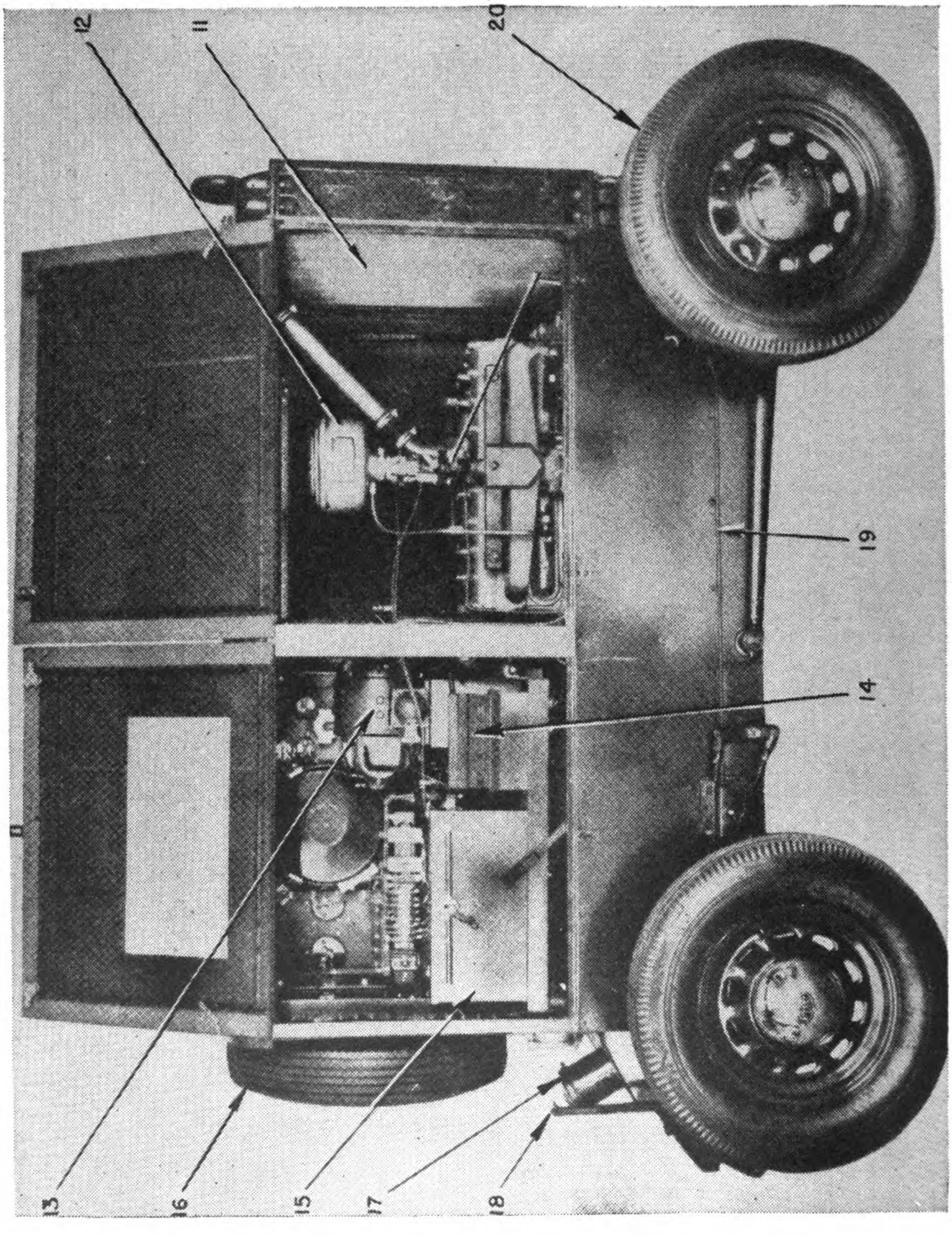


FIGURE 97.—Sperry M1941 power plant (right side).

Part	Purpose or use
11. Radiator	Cools the liquid in the engine cooling system.
12. Air filter	Filters the air going into the carubretor.
13. Fan motor	A ¾ hp, d-c motor, having two speeds: winter—500 rpm; summer—675 rpm.
14. Battery	Furnishes 6 volts for the engine ignition system and 6-volt lights on the control panel and the tail light.
15. Tool box	Storage place for tools.
16. Spare wheel and tire	Self-explanatory.
17. Full tank filler pipe	Self-explanatory.
18. Brake lever	Self-explanatory.
19. Safety chain brake cable	Operates, in case the safety chain breaks, to apply the brakes on the power plant.
20. Exhaust	Self-explanatory.

b. General Electric power plants.—*Q.* What difference is there between the Sperry M1941 and the General Electric M1940 power plants? *A.* Very little. The engines are the same except the Sperry runs at 1,100 rpm and the General Electric at 1,200 rpm. The generators are made by different manufacturers, but both deliver 150 amperes at 78 volts to the searchlight.

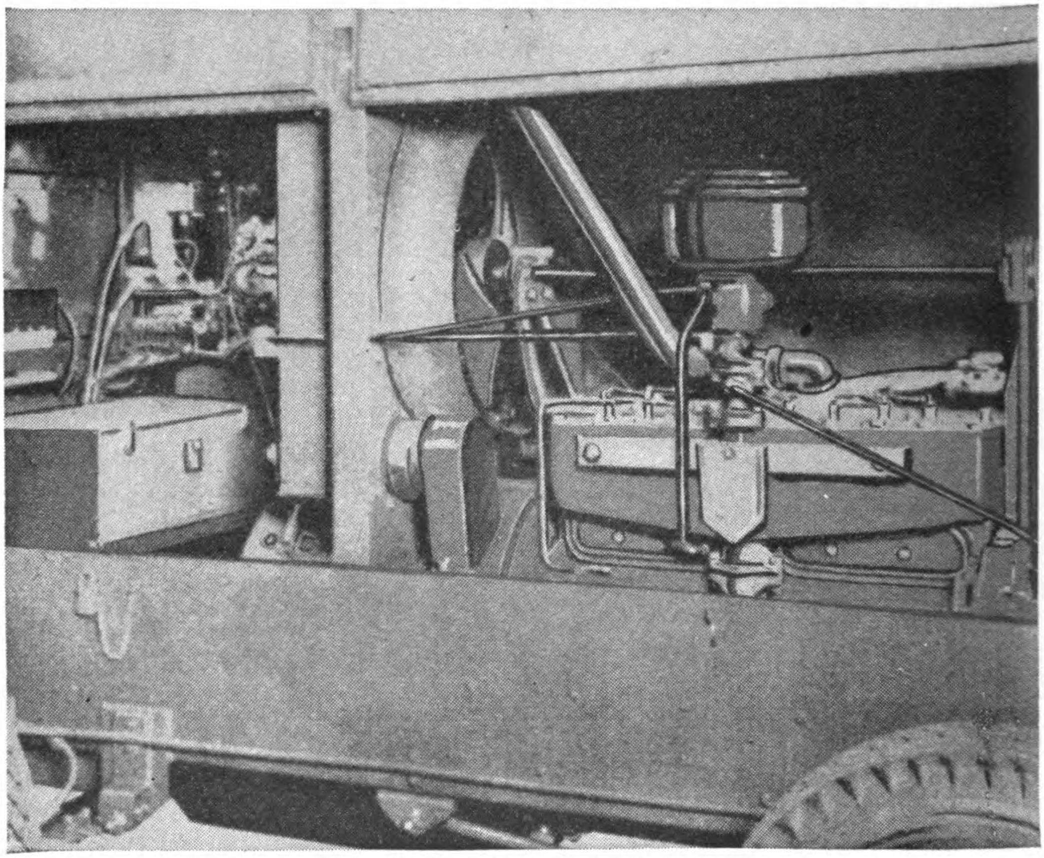


FIGURE 98.—General Electric M1940 power plant.

Q. What is the rating of the generator of the M1940 General Electric power plant? *A.* It is rated as follows:

Volts	*Amperes*	*Rpm*	*Kilowatts*
100	160	1,200	16.2

Q. Is the nomenclature of the Sperry and the General Electric power plants similar? *A.* Yes. Parts (compare fig. 98 with figs. 96 and 97) correspond except as follows:

(1) The General Electric tank holds 26 gallons.

(2) The General Electric tail lamp switch is located on the tail lamp.

(3) The General Electric fan is driven by a pulley from the main crankshaft.

SECTION IV

NOMENCLATURE OF SOUND-LOCATOR APPARATUS

64. General.—*Q.* What is a sound locator? *A.* A sound locator is an instrument which can "pick up" and locate accurately an airplane by means of the sound it emits.

Q. What are the two types of sound locators now in use? *A.* The M1 series sound locator and the M2 sound locator.

Q. Of what does a sound locator consist? *A.*

(1) Horns for collecting sound.

(2) Sound track to listener's helmet.

(3) Listener's helmet.

(4) A mounting for the horns so that the locator may be moved in azimuth and elevation by handwheels.

(5) An acoustic corrector to correct for "sound lag."

(6) A data transmission system to send corrected data to the searchlight so it may be pointed correctly.

Q. What is meant by "sound lag"? *A.* Sound travels in air at about 1,100 feet per second. This means that it takes the sound coming from an airplane some time to arrive at the sound locator. During this time, called "sound lag time," the airplane has traveled certain angular amounts in azimuth and in elevation known as the "sound lag angle."

Q. What is the function of the acoustic corrector? *A.* The acoustic corrector must correct the azimuth and elevation data for the sound lag angle.

65. M1 series sound locators.—*Q.* What is the weight of an M1 series sound locator? *A.* 2¾ tons.

Q. How many horns are used on the M1 sound locator? *A.* Four.

Q. Are all sound locators of the M1 series similar? *A.* Yes. From the M1A1 to the M1A8, they are all identical except for minor manufacturing changes.

Q. What kinds of sights are provided for orienting the M1 series sound locator? *A.* Open sights. They are to be placed on the lower elevation horn.

Q. Point out and give purpose of the parts of an M1 series sound locator. *A.* See figure 99.

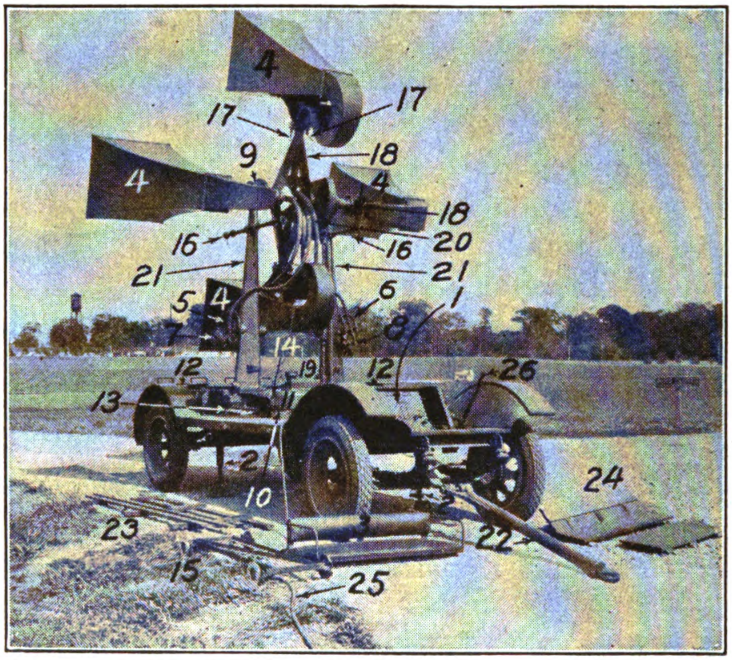


FIGURE 99.—Sound locator M1A1.

Part	Purpose or use
1. Acoustic corrector	To correct for the "sound lag" angle.
2. Jacks	There are four jacks for leveling the sound locator.
3. Front seat (removed)	Sound locator listeners ride on this seat during road marches.
4. Horns	These four horns collect and amplify sound. Upper and lower horns are elevation horns. Right and left horns are azimuth horns.
5. Traversing handwheel	The azimuth listener uses this handwheel to track the sound source in azimuth.
6. Elevating handwheel	The elevation listener uses this handwheel to track the sound source in elevation.
7. Azimuth helmet	The two azimuth horns are connected by sound track tubing to this helmet so the listener can hear sounds picked up by the horns.
8. Elevation helmet	The two elevation horns are connected by sound track tubing to this helmet so the listener can hear sounds picked up by the horns.
9. Horn bearings	Bearings are mounted on the top of each vertical column so the horns may be elevated easily.
10. Azimuth circle	Used to orient the sound locator with the searchlight. The circle can be slipped around for adjustment.
11. Turntable	The vertical column and horn assembly are supported on, and turn with, the turntable.
12. Seats for listeners	The azimuth listener is seated on the left seat, the elevation listener on the right seat.
13. Foot rest	Each listener has a foot rest.
14. Adjustable locking screws	Three screws are used to lock the turntable in azimuth for traveling on the road.
15. Horn locking frame	When the horns are mounted for traveling, this frame holds them rigidly in their traveling position.
16. Traveling horn supports	The four horns are removed from their operating positions and put on these supports for traveling.
17. Hand clamp screws	These clamp screws lock the horns in their operating position.
18. Horn support sections	These sections support the horns in their operating position.
19. Elevation control shaft	This shafting leads from the elevation handwheel to the gears which elevate the horns.
20. Rubber tubes	These are sound track tubes conducting the sound from the horns to the listeners' helmets.
21. Vertical columns	These vertical columns support the horns.
22. Towing bar	Used for towing the sound locator by its towing truck.
23. Side frames	These two frames are placed one on each side of the sound locator so that cables and other equipment will not fall off when on the road.
24. Covers for acoustic corrector	These removable wooden covers fit over the acoustic correctors for traveling.
25. Cable leading to the control station.	Sound locator data are sent to the control station through this cable.
26. Brake handle	This operates the parking brake. The brakes are located on the rear wheels.

Q. What acoustic correctors are used with the M1 series sound locators? *A*. The M1, the M1A1, and the M2 acoustic correctors.

Q. How many men are required to operate the M1 series sound locator? *A*. Four men when the M1 or the M1A1 acoustic corrector is furnished. Three men when the M2 acoustic corrector is provided.

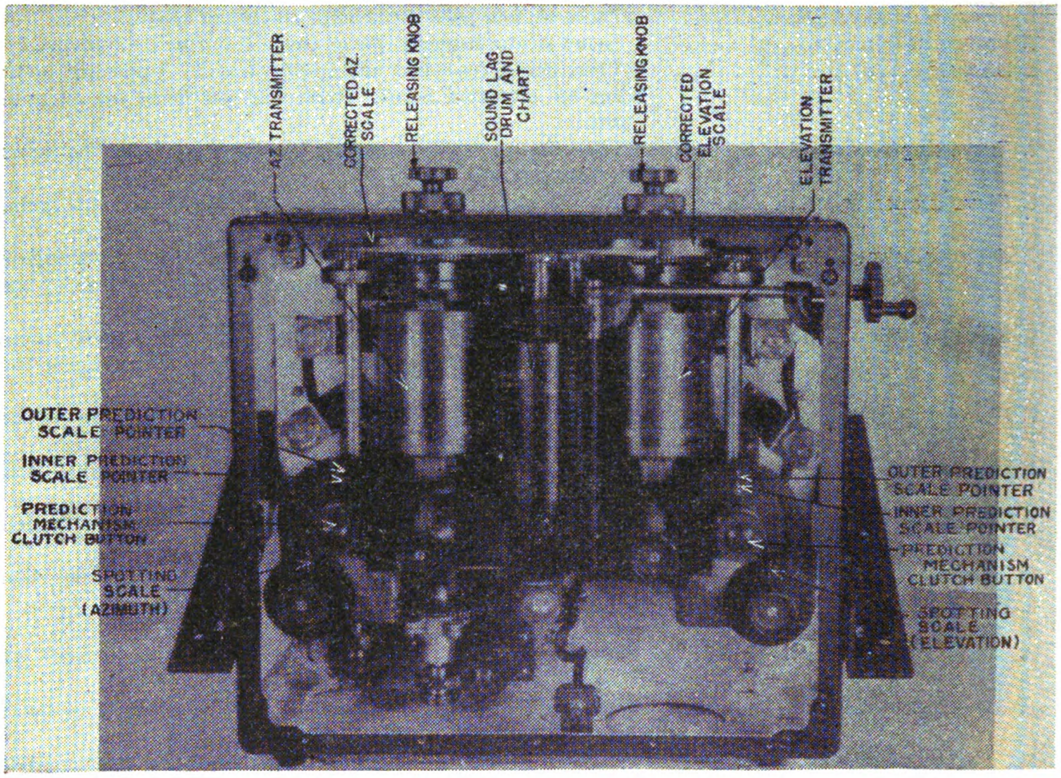


FIGURE 100.—Acoustic corrector M1.

Q. What is the difference between the M1 and M1A1 acoustic correctors? *A*. The M1 has the azimuth scale graduated in degrees, the M1A1 in mils.

Q. Give the nomenclature of the M1 acoustic corrector. *A*. See figure 100.

Q. Give the nomenclature of the M2 acoustic corrector. *A*. See figure 101.

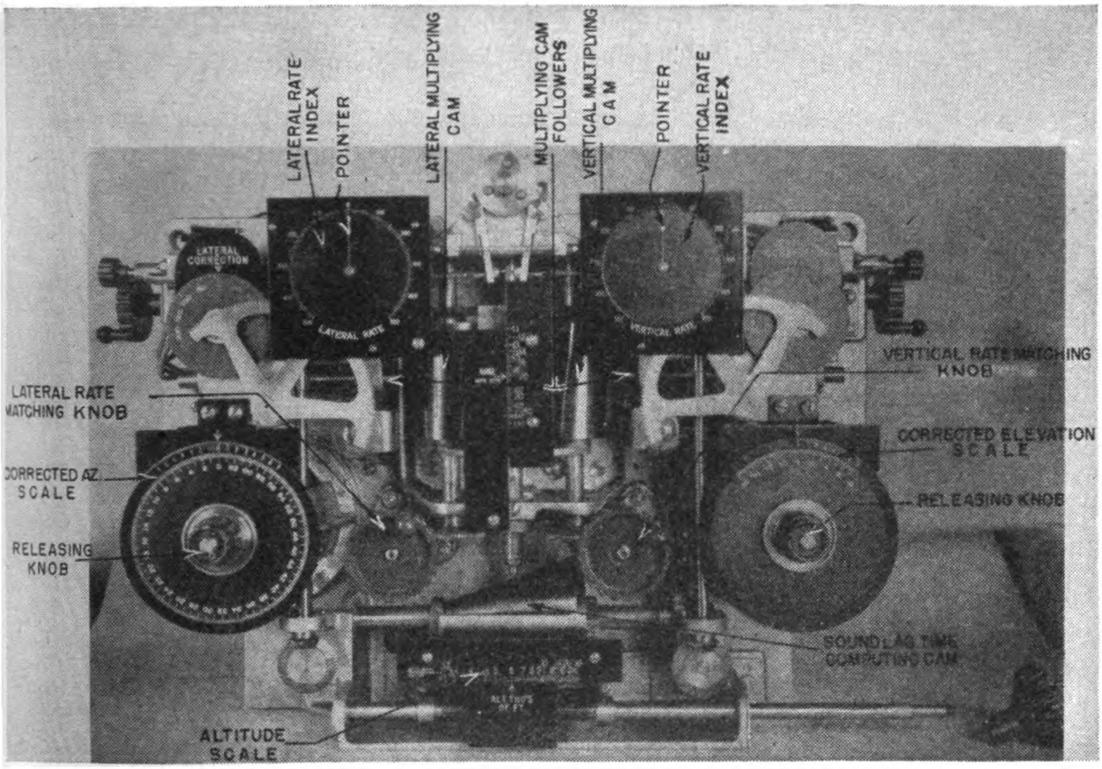


FIGURE 101.—Acoustic corrector M2.

66. M2 sound locator.—*Q.* What is the weight of the M2 sound locator? *A.* 1,066 pounds.

Q. What are the six component parts into which the M2 sound locator is broken up for transportation? *A.*

(1) Two-horn assembly.
(2) Single-horn assembly.
(3) Corrector assembly (in carrying case).
(4) Column.
(5) Platform.
(6) Cable and cable reels.

Q. Which horn is a common horn for the azimuth and elevation listeners? *A.* Upper right horn, figure 103.

Q. How many men does it take to operate the M2 sound locator? *A.* Three. The azimuth and elevation listeners and the acoustic corrector operator, under supervision of the chief of section.

Q. Give the nomenclature and state the purpose or use of each part of the M2 sound locator. *A.* See figure 103.

FIGURE 102.—Corrector operator in action.

Part	Purpose or use
1. Multiplying pantograph	This causes the pantograph ball to be offset by the sound lag angle both in azimuth and elevation.
2. Target air speed setting knob	Air speed of the target is set in on the miniature airplane which is positioned so as to be parallel to the target's course.
7. Pantograph attacking stud knob	Holds pantograph in correct position.
8. Parallax cam	Parallax corrections are set in on the cam parallax scale.
9. Declutching gear	Push down on this gear so that the parallax arrow may be pointed at searchlight.
10. Target air speed scale	Air speed of airplane is indicated in miles per hour. Use knob (part 2) to set in correct air speed.
11. Pantograph pointer and ball	The corrector operator centers the pantograph ball on the cross lines of mirror (part 12).
12. Mirror and cross lines	The image of the pantograph is seen in this mirror.
13. Level	To level sound locator.
14. Elevation clamp	To lock horns at any desired elevation.
15. Parallax scale	Set parallax cam to the correct figure on this scale.

Q. Point out the following parts and give the purpose or use of the part. *A*. See fig. 103.

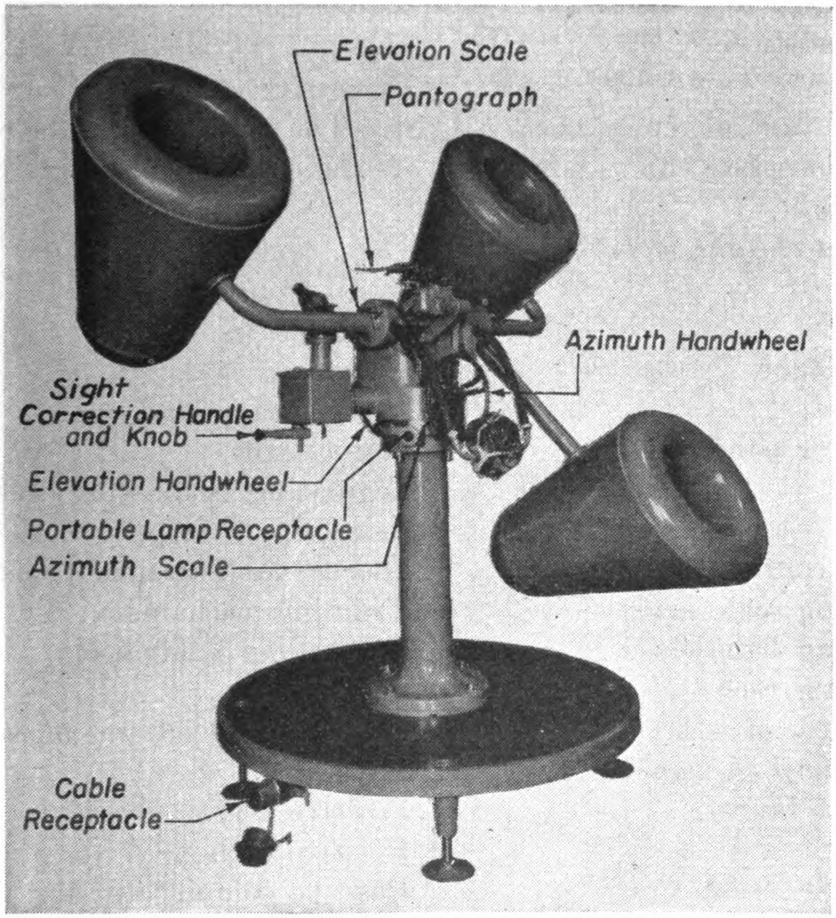


FIGURE 103.—Sound locator M2.

Part	Purpose or use
Elevation scale	A scale graduated in mils for elevating the horns to any desired elevation.
Sight crank handle and knob	The corrector operator uses this handle and knob to keep the pantograph ball centered in the sight mirror cross lines.
Azimuth handwheel	The azimuth listener uses this handwheel to track the sound source in azimuth. There is an azimuth clamp knob on the shaft of this handwheel to lock the sound locator while orienting.
Elevating handwheel	The elevation listener uses this handwheel to track the sound source in elevation.
Azimuth scale	For use in orienting the sound locator. The scale can be moved around to any desired azimuth.
Portable lamp receptacle	For plugging in the trouble lamp.
Cable receptacle	Blue cable plug is inserted in this receptacle.
Common horn	Used to collect sound for both azimuth and elevation. (Upper right horn, fig. 103.)
Elevation horn	Used to collect sound for azimuth. (Lower right horn, fig. 103.)
Azimuth horn	Used to collect sound for azimuth. (Left horn, fig. 103.)

SECTION V

NOMENCLATURE OF SEACOAST SEARCHLIGHT

67. Fixed seacoast searchlight.—The candidate will be required to demonstrate his knowledge of the component parts of the searchlight.

a. Searchlight, general.

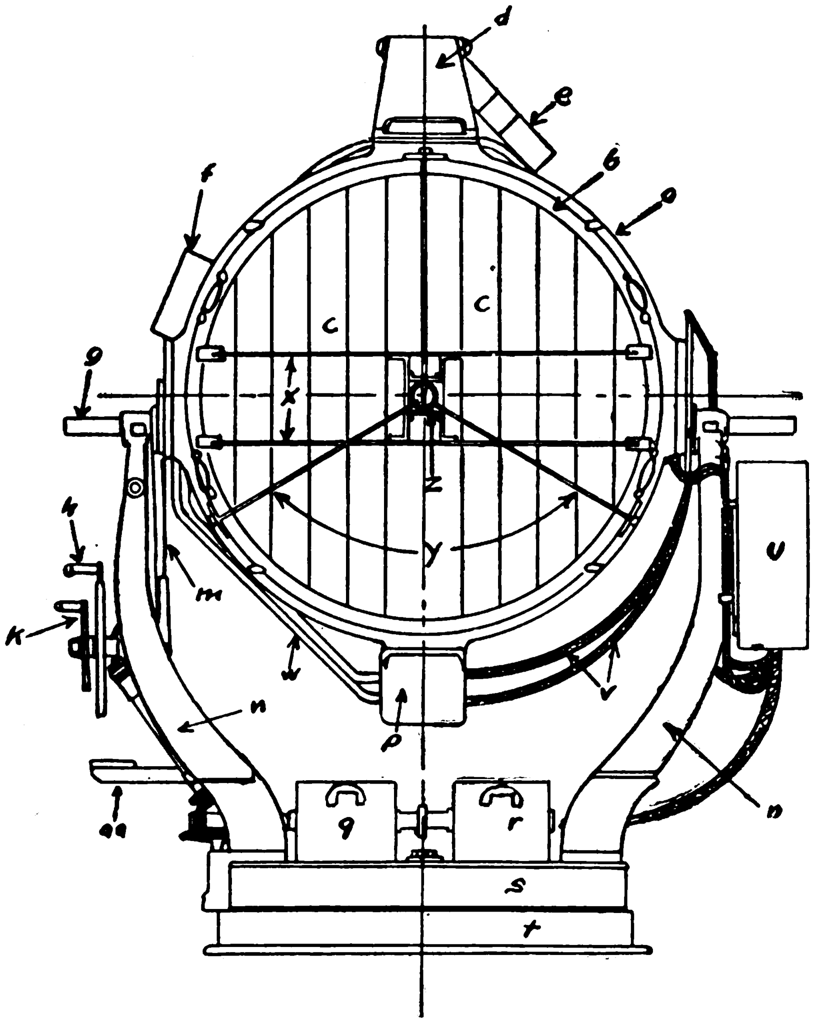
Base.
Braces.
Carbon tube.
Conduits.
Contactor panel box.
Door.
Drum.
Drum trunnions.
Elevating scale arm.
Elevating handwheel.
Elevating rack.
Glass door strips.
Lamp trough.
Muffler.
Mirror.
Mirror frame and dome.
Power leads.
Regulating (ballasting) resistance.
Reinforcing strips.
Thermostat instrument box.
Training mechanism.
Traversing handwheel.
Turntable.
Ventilating hood and motor.

b. Lamp mechanism.

Air tube braces.
Control box.
Focusing screw.
Front cap and stray light shield.
Feed motor.
Main lamp feed cables.
Negative carbon.
Negative carbon hand feed crank.
Negative carbon release shaft.
Negative column air tube.
Negative contact.
Negative feed gear.
Negative feed shaft.
Negative head.
Negative head compression spring.
Negative head compression spring lever.
Positive cap.
Positive carbon.
Positive column air tube.
Positive contact brushes.
Positive head.
Positive head bevel gear.
Positive head driving shaft.
Positive feed rollers.
Quartz bushing.
Star wheel.
Star wheel feed rod.
Thermostat magnet hand control lever.
Ventilating vents.
Voltage regulator.
Voltage regulator thumb knob.

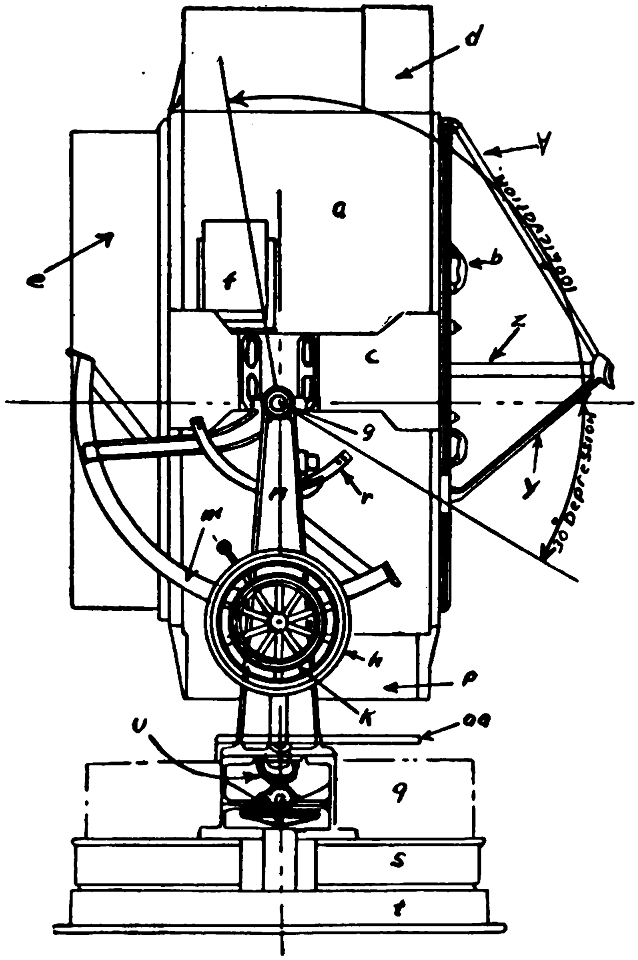
c. Control instruments.

Ammeter.
Arc length rheostat.
Carboning lamp switch.
Ground glass finder.
Ground glass finder lens tubes.
Local and remote control switch.
Mainline contactors.
Mainline contactor relay.
Off-and-on lamp control switch.
Overload relay.
Thermostat adjusting arm.
Thermostat adjusting screw.
Thermostat clamping arm.
Thermostat instrument.
Thermostat magnet.
Thermostat mirror.
Thermostat push button.
Voltmeter.



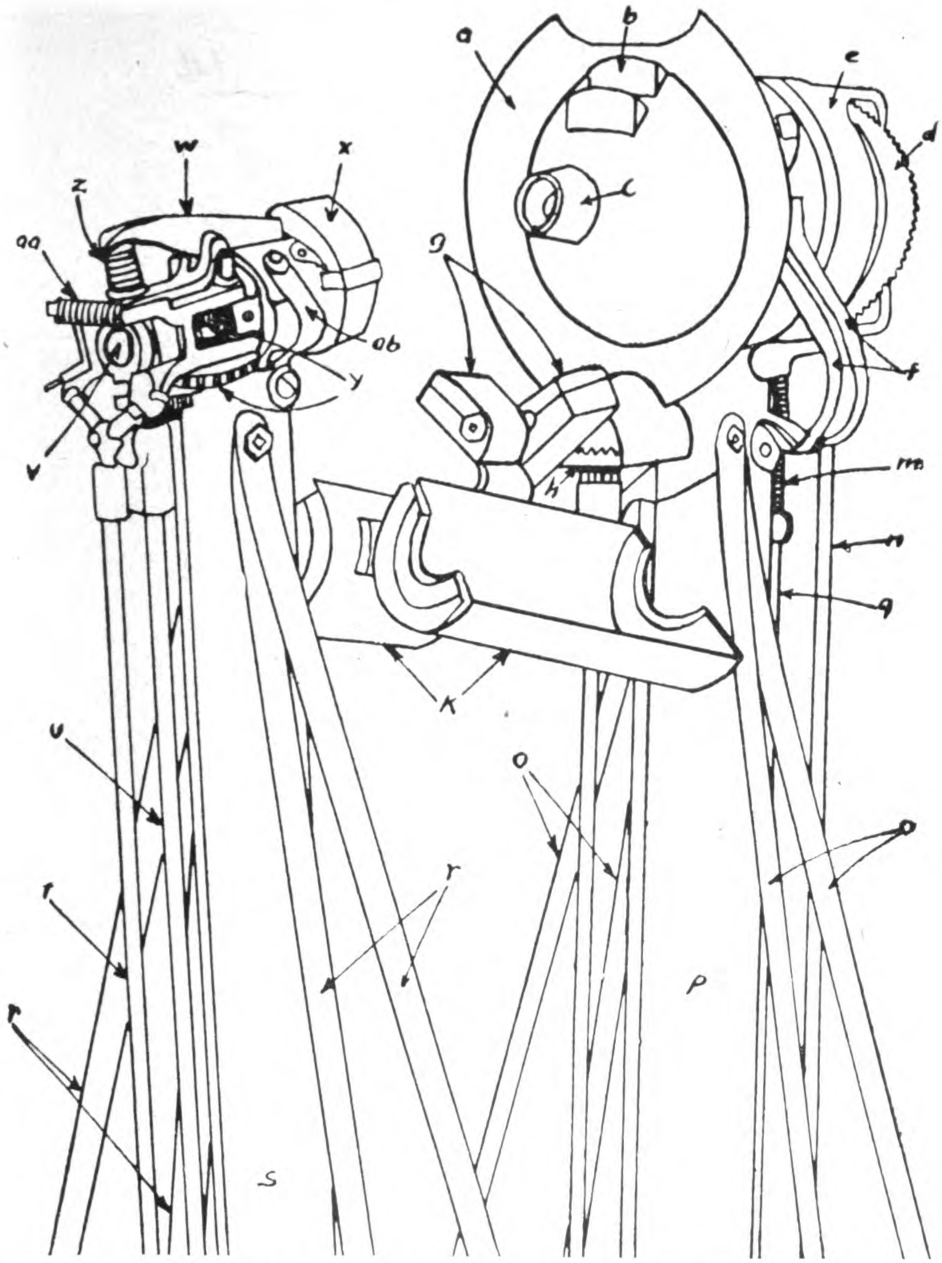
a. Drum.
b. Door.
c. Glass door strips.
d. Ventilating hood and motor.
e. Muffler.
f. Thermostat instrument box.
g. Drum trunnions.
h. Traversing handwheel.
k. Elevating handwheel.
m. Elevating rack.
n. Right and left arms.
p. Lamp trough.
q. and r. Training mechanism boxes.
s. Turntable.
t. Base.
u. Contactor panel box.
v. Power leads.
w. Conduits.
x. Reinforcing strips.
y. Braces.
z. Carbon tube.
aa. Operator's platform.

FIGURE 104.—Front view, 60-inch fixed searchlight.



a. Drum.
b. Door handles.
c. Side plate.
d. Ventilating hood.
e. Mirror frame and dome.
f. Thermostat instrument box.
g. Drum trunnion.
h. Traversing handwheel.
k. Elevating handwheel.
m. Elevating rack.
n. Right arm.
p. Lamp trough.
q. Training mechanism box.
r. Elevating scale arm.
s. Turntable.
t. Base.
u. Training gears.
y. Braces.
z. Carbon tube.
aa. Operator's platform.

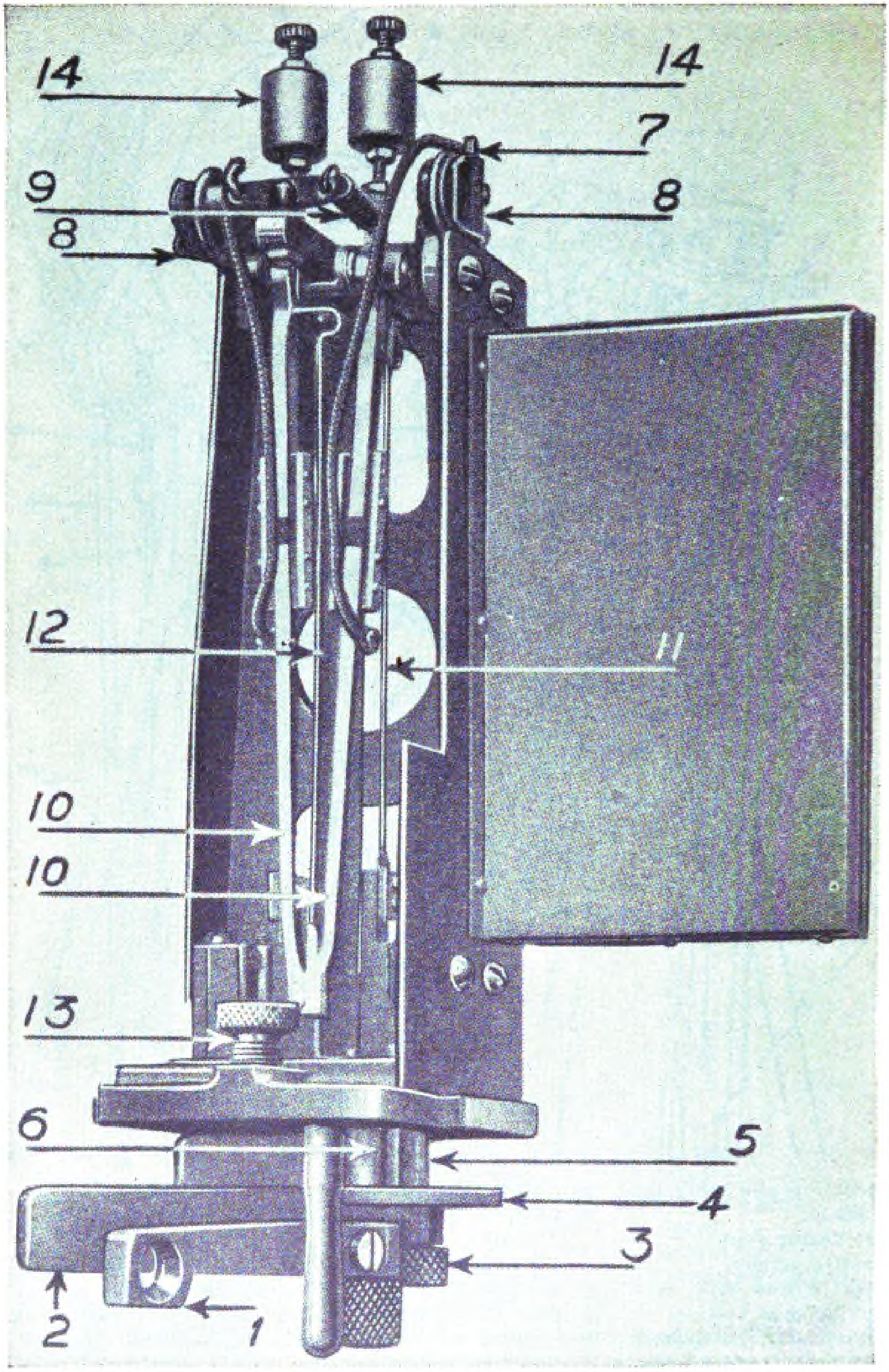
FIGURE 105.—Right side view, 60-inch fixed searchlight.



a. Front cap and stray light shield.
b. Ventilating vents.
c. Positive carbon.
d. Positive head bevel gear.
e. Bearing cage casting.
f. Contact strip brush leads.
g. Occulter counterbalance weights.
h. Occulter gear.
k. Occulter caps.
m. Star wheel feed rod spring.
n. Positive head driving shaft.
o. Air tube braces (positive).
p. Positive column air tube.
q. Star wheel feed rod.
r. Air tube braces (negative).
s. Negative column air tube.
t. Negative carbon release shaft.
u. Negative feed shaft.
v. Negative carbon.
w. Compression spring lever.
x. Negative head.
y. Negative feed gear.
z. Compression spring.
aa. Feed roller bracket spring.
ab. Negative contact strip leads.

Note.—The above columns and shafts extend down to and, in the case of the shafts, into the control box.

FIGURE 106.—Positive and negative heads and columns.



1. Clamping arm.
2. Adjusting arm.
3. Adjusting screw.
4. Clamping bracket.
5. Adjusting screw sleeve.
6. Clamping arm stud.
7. Thermostat lead.
8. Thermostat contact shoe.
9. Contact arm spring.
10. Contact arm.
11. Thermostat zinc strip.
12. Shadow plate.
13. Set screw.
14. Counterbalance weights.

FIGURE 107.—Thermostat unit.

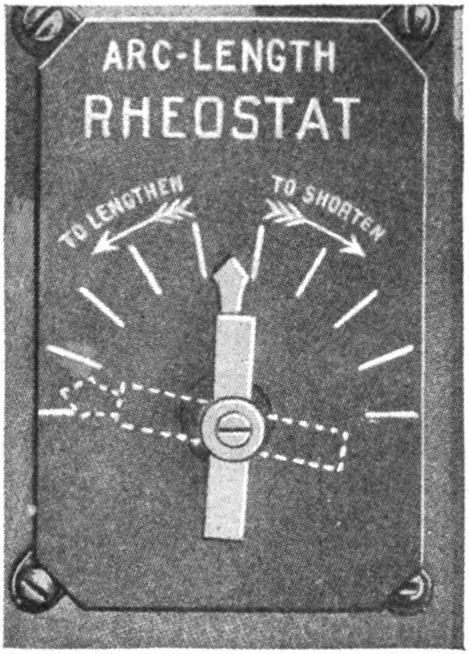
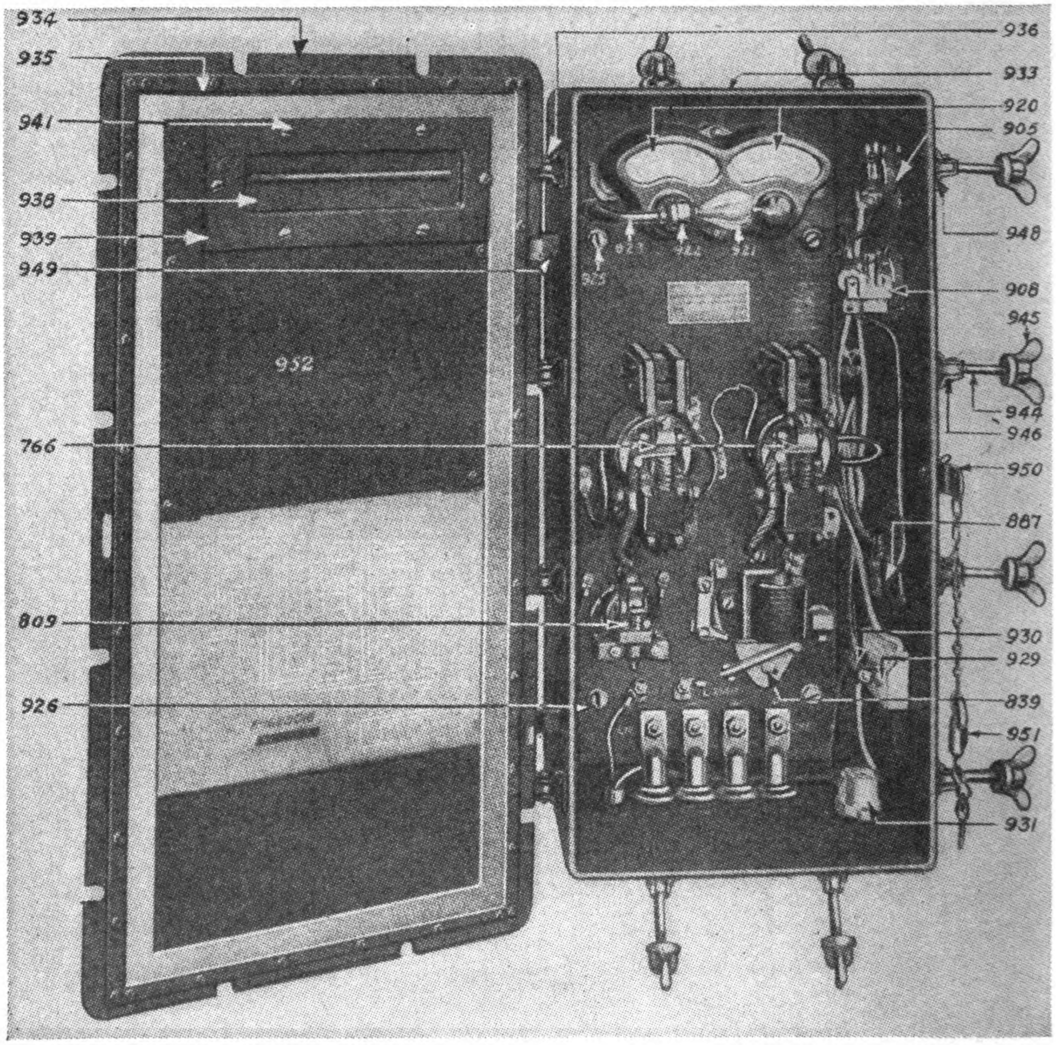


FIGURE 108.—Arc length rheostat.

FIGURE 109.—Thermostat pushbutton.



809. Mainline contactor relay.
839. Overload relay.
887. Local and remote control lamp switch.
905. Carboning lamp switch.
908. Off-and-on lamp control switch.
920. Ammeter-voltmeter.
921. Lamp for contactor box.
929. Fuze block.
931. Portable lamp receptacle.
766. Mainline contactor.

FIGURE 110.—Contactor panel.

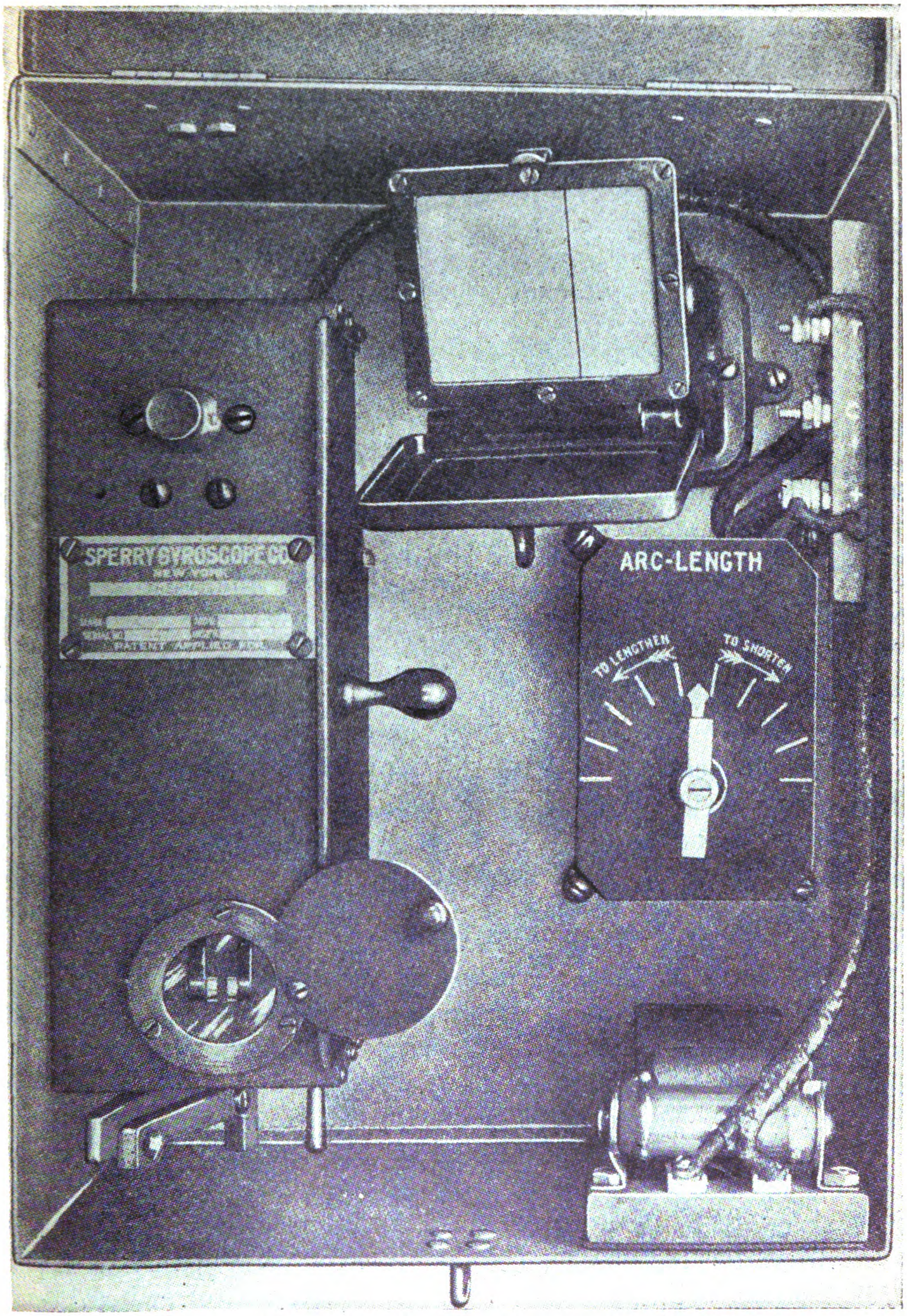


FIGURE 111.—Instrument box complete.

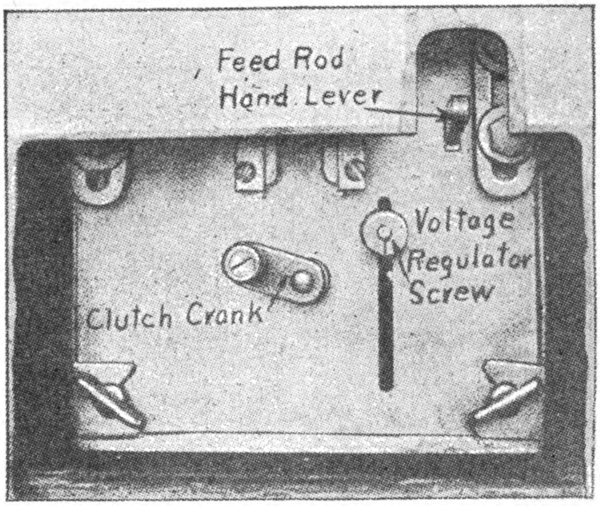


FIGURE 112.—Operating end view of control box.

68. Mobile seacoast searchlight.—This light is identical with 60-inch antiaircraft searchlight. For nomenclature see section III.

SECTION VI

NOMENCLATURE OF CONTROL SYSTEM FOR SEACOAST SEARCHLIGHTS

69. Fixed seacoast searchlight control system.—*Q*. What is the standard type of control system for fixed seacoast searchlights? *A*. The synchronous-relay type is the present standard type for fixed seacoast searchlights. The General Electric synchronous type is the old standard and may be found on some installations. It operates on the same general principle as the standard type.

Q. Of what does the control system consist? *A*. The control system consists of two sets of apparatus, one for training in azimuth and the other for training in elevation. Each set consists of the following essential elements: controller, pilot motor, cam cylinder, training motor, magnetic clutch, and intermediate gearing.

Q. Identify the following listed parts:

(1) *Controller:*

1831. Azimuth handwheel.
Elevation handwheel.
1869. Contact cylinder.
1879. Contact finger.
Gear shift coil.
1928. Lamp.
1929. Azimuth dial.
1930. Azimuth dial index.
1943. Speed control switch.
1946. Controller cable receptacle.
908. Lamp control switch.

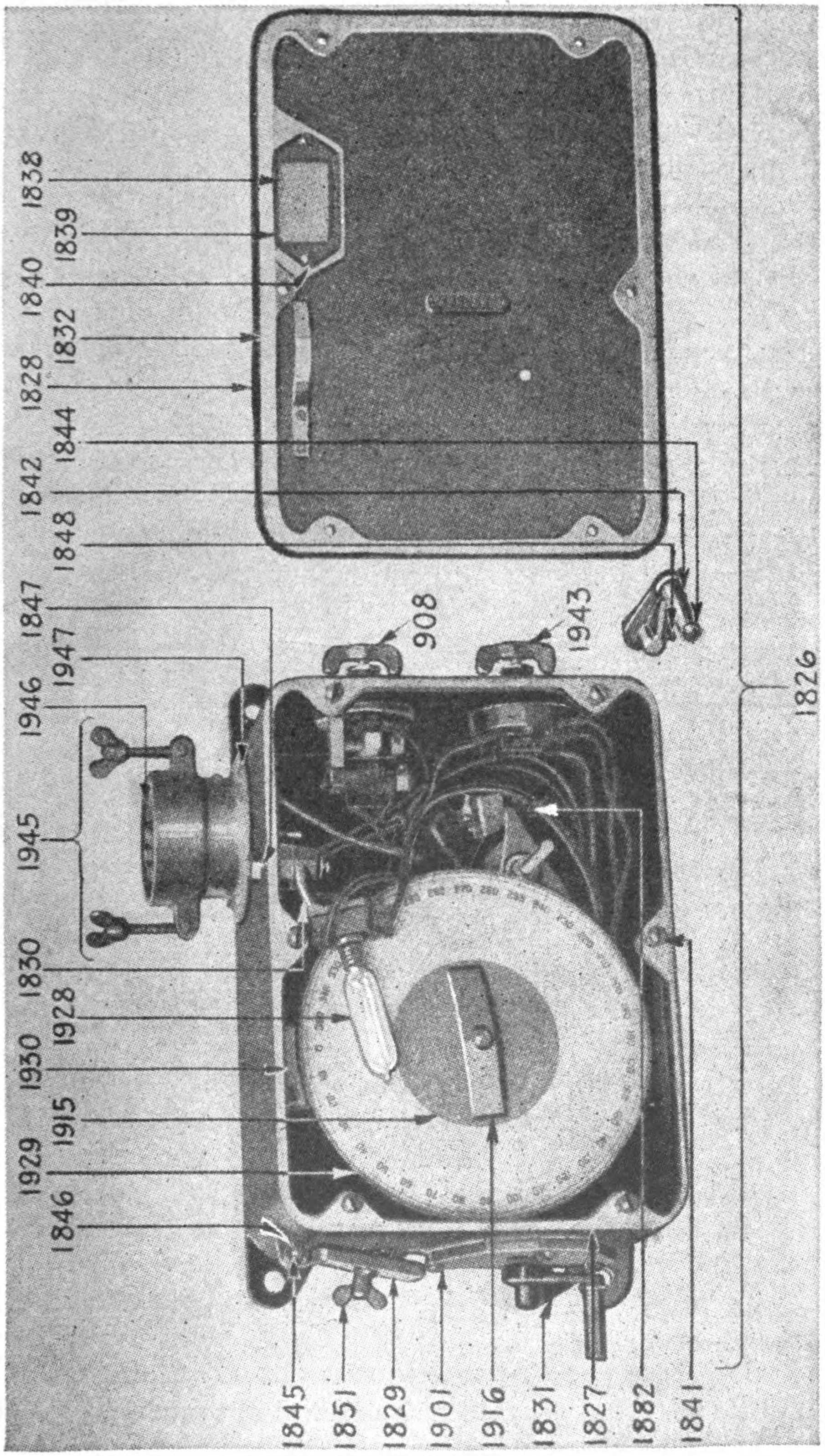


FIGURE 113.—Controller.

(2) *Training mechanism* (*on light*):

Azimuth scale.
Elevation scale.
1688. Gear shift contactor.
1714. Magnetic clutch, azimuth.
1713. Magnetic clutch, elevation.
Pilot motor, azimuth.
Pilot motor, elevation.
1794. Slip clutch, elevation.
1635. Training contactors.
Training motor, azimuth.
1610. Training motor, elevation.

A. See figures 113 and 114.

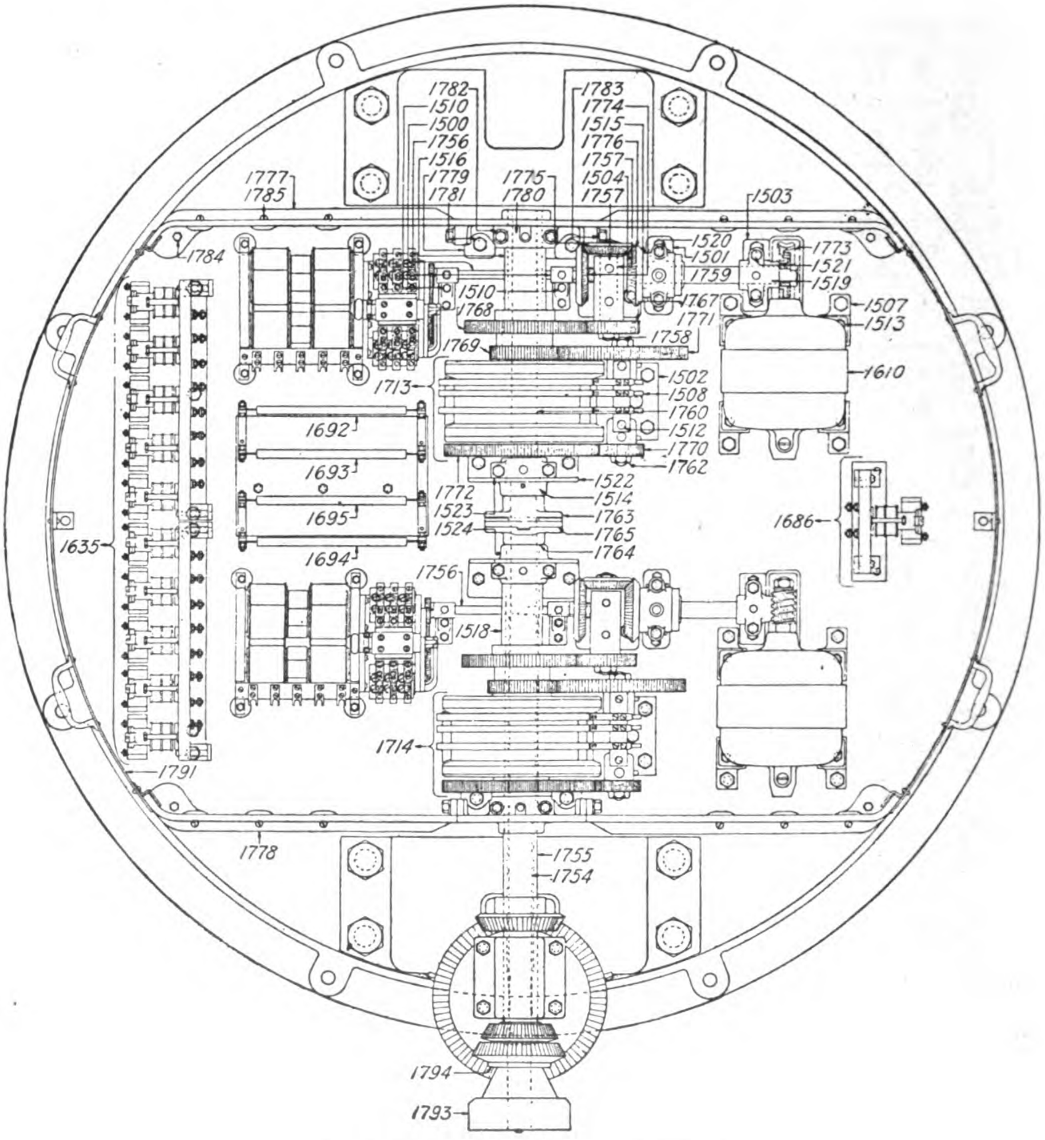


FIGURE 114.—Training mechanism.

70. Mobile seacoast searchlight control system.—The control system for this type of light is identical with that of the antiaircraft searchlight. (Refer to the proper paragraph and type under section III.)

SECTION VII

CARE AND OPERATION OF ANTIAIRCRAFT SEARCH-LIGHT POWER PLANT

71. General.—Beginning with the M1934 portable power plant, all models are fundamentally the same. This is especially true of the Sperry power plants of M1937, M1939, M1940, and M1941, and the General Electric power plant of M1940. The M-VI and M1934 mobile power plant generators are driven by the vehicle engines through suitable transmissions.

Q. What is the principal purpose of a power plant? *A.* To furnish direct current power to operate the arc.

Q. Name the two principal parts of a power plant. *A.* A *gasoline engine* which furnishes motive power to drive a *direct current generator*.

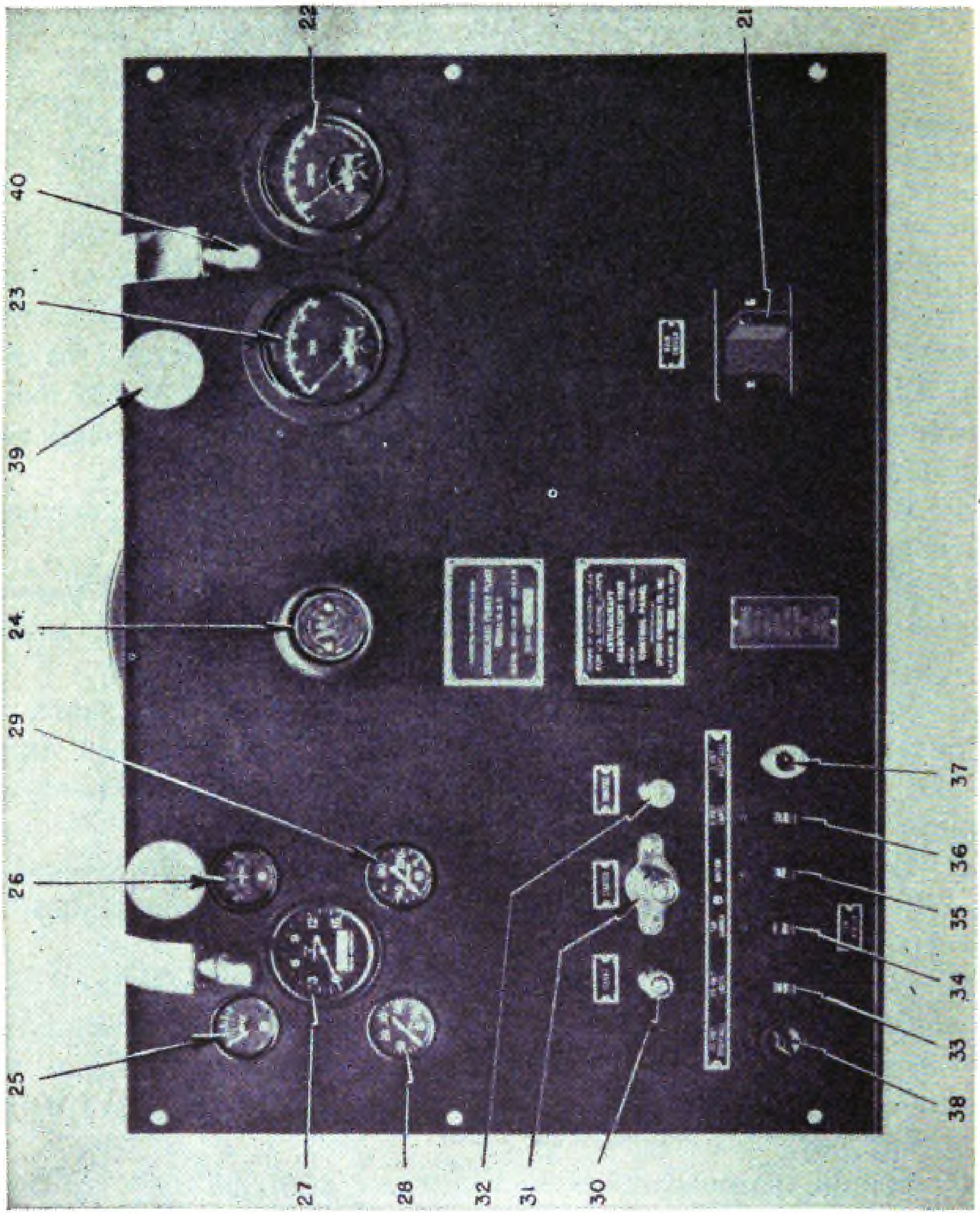
Q. What is the purpose of a governor on the power plant? *A.* A governor is a device on an engine which controls the fuel supply to the engine in such a way that the engine-generator speed will remain constant from no load to full load.

Q. What is supplied to control the power output of the generator? *A.* All necessary control apparatus, meters, and engine indicators, mounted on a control panel.

Q. How does the engine adjust itself between "arc load" and "listening load" conditions? *A.* Automatically. The governor control system, having once been adjusted for arc load condition, will regulate the engine speed and maintain it at the proper speed during listening load.

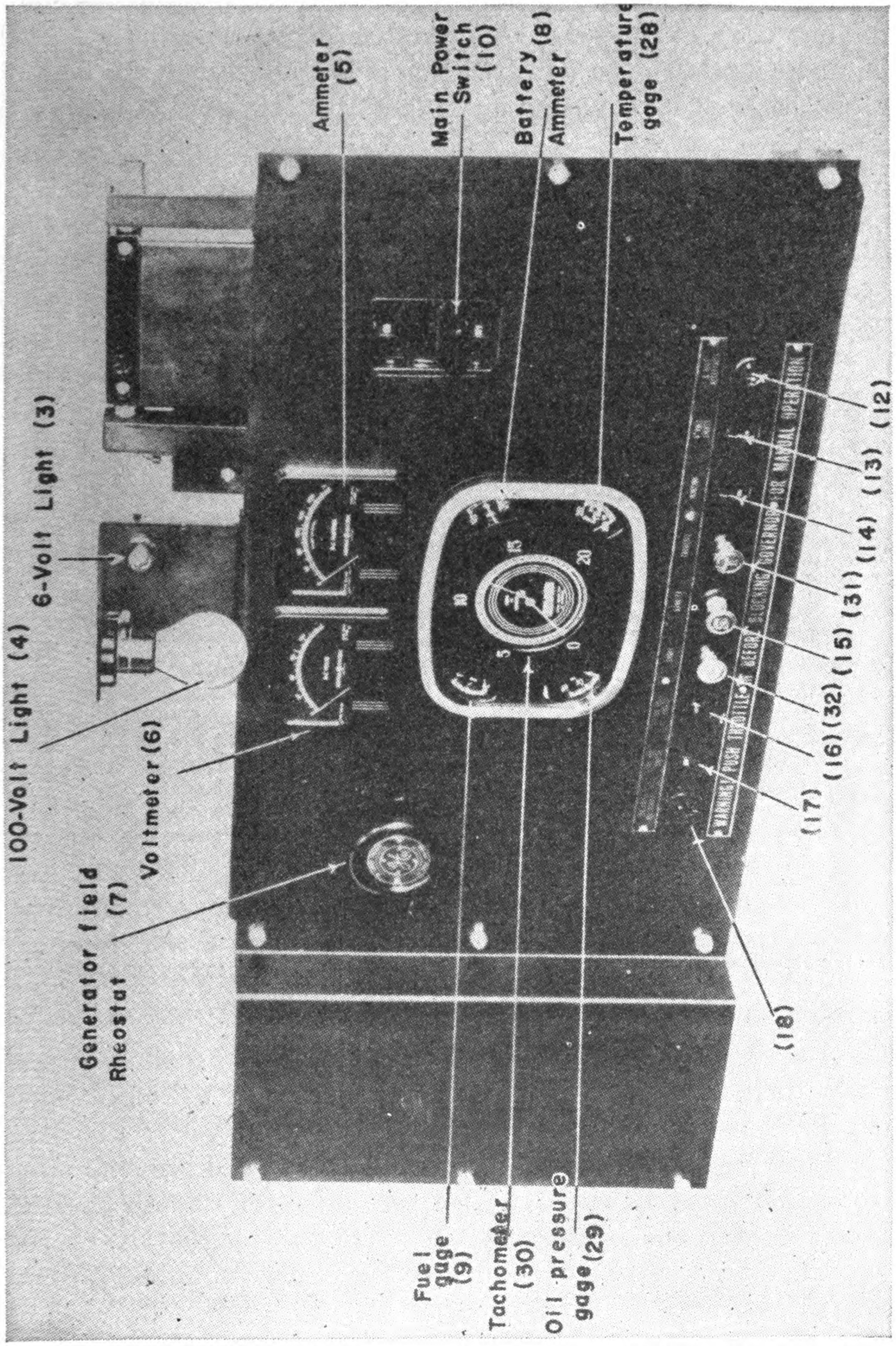
Q. Should the hood doors on the power plant be open while the plant is operating? *A.* On the Sperry power plants M1934 portable, M1937, M1939, M1940, and M1941, and the General Electric M1940, the hood doors next to the radiator should be kept closed at all times while the power plant is operating. The switch board (control panel) hood door should be open. On the M-VI power plant the side hoods of the vehicle engine should be raised or taken off while the power plant is operating to drive the generator.

Q. On the Sperry M1934 portable, M1937, M1939, M1940, and M1941 and the General Electric M1940 power plants, why is it necessary to have the hood doors next to the radiator closed while the power plant is



21. Main switch.
22. Power ammeter.
23. Power voltmeter.
24. Voltage regulating rheostat.
25. Gasoline gage.
26. Charging meter.
27. Tachometer and revolution counter.
28. Oil pressure gage.
29. Temperature gage.
30. Choke control.
31. Starter button.
32. Throttle control.
33. 115-volt light switch.
34. Fan season switch.
35. Ignition switch.
36. 6-volt light switch.
37. 6-volt receptacle.
38. 115-volt receptacle.
39. 115-volt panel lights.
40. 6-volt panel lights.

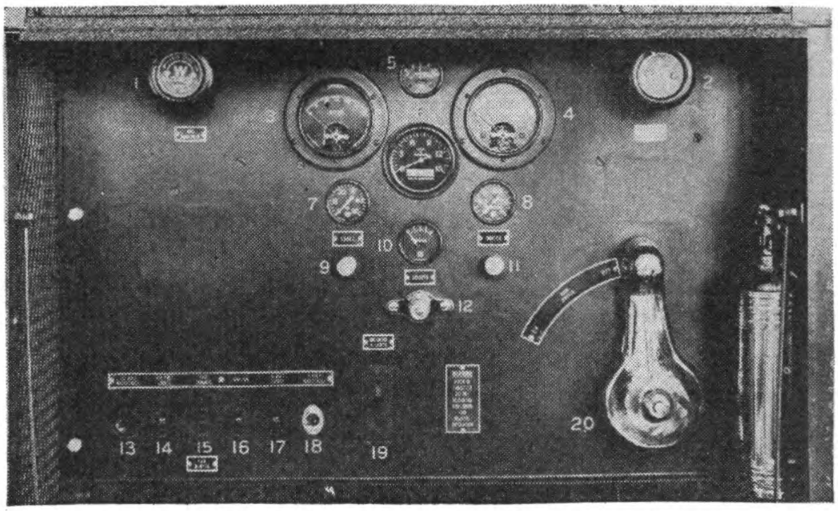
FIGURE 115.—Sperry control panel M1941. (Sperry control panel M1940 is same as Sperry control panel M1941 except that circuit breaker is substituted for main switch.)



12. 6-volt receptacle.
13. 6-volt light switch.
14. Ignition switch.
15. Starter.
16. 100-volt light switch.
17. 100-volt switch.
18. 100-volt receptacle.
31. Throttle.
32. Choke.

FIGURE 116.—General Electric control panel M1940.

operating? *A.* The cooling fan is located at the rear of the engine and blows the air across the engine and through the radiator. If the hood doors are left open no cooling air will pass thrugh the radiator but will pass out through the hood door openings and will cause the engine to overheat.



1. Arc load voltage rheostat.
2. Listening load voltage rheostat.
3. Power ammeter.
4. Power voltmeter.
5. Charging ammeter.
6. Tachometer and revolution counter.
7. Oil pressure gage.
8. Temperature gage.
9. Choke.
10. Gasoline gage.
11. Throttle.
12. Starter button.
13. 115-volt lamp receptacle.
14. 115-volt light switch.
15. Fan season switch.
16. Ignition switch.
17. 6-volt light switch.
18. 6-volt receptacle.
19. Power voltmeter and lamp circuit breaker.
20. Main switch.

FIGURE 117.—Sperry control panel M1939. (Sperry control panel M1937 is same as for Sperry control panel M1939 except that circuit breaker is substituted for main switch.)

Q. How would you start the power plant? *A.*

(1) *Sperry M1937, M1939, M1940, and M1941, and General Electric M1940.*—(*a*) Throw main switch or circuit breaker to "off" position.

(*b*) Pull out choke and throttle about half way.

(*c*) Start engine by turning on ignition switch and pressing starter button. After engine starts, adjust the choke for smooth operation and pull the throttle all the way out. After the engine has warmed up and has been operating smoothly for a few minutes, push the choke back in.

(2) *Portable power plant M1934.*—(*a*) Throw main switch to "off" position.

(*b*) Turn on ignition switch.

(*c*) Start the engine by pressing starter button and choking as required.

(*d*) When the engine warms up, decrease choking until no further choking is required.

(3) *Mobile power plant M1934.*—The engine in this case is the engine which drives the truck, so its starting is similar to that of any vehicle motor.

(*a*) Open generator ventilating covers.

(*b*) Start engine and permit it to operate at idling speed.

(*c*) Close auxiliary circuit breaker.

(*d*) Disengage the truck clutch.

(*e*) Remove chain from the generator clutch lever and move lever toward the rear of the truck to the generator position.

(*f*) Put truck transmission gear shift lever in fourth gear.

(*g*) Reengage the foot clutch slowly.

(*h*) Push foot throttle down slowly to full open position and pull out the hand throttle to the full open position.

(4) *Mobile power plant M–VI.*—The engine in this case is the engine which drives the vehicle so its starting is similar to that of any vehicle motor.

(*a*) Open ventilator covers on the generator.

(*b*) Raise both sides of engine hood.

(*c*) Open switch and circuit breaker on power panel.

(*d*) Start engine and permit it to operate at idling speed.

(*e*) Close the cut-out to the second muffler by raising the cut-out button.

(*f*) Shift the generator clutch lever to its rear (generator) position.

(*g*) Depress the engine clutch, place gear shift in "high," and let out engine clutch slowly.

(*h*) Press in governor cut-out button on dash.

(*i*) Accelerate the engine by gradually advancing the hand throttle to its wide open position. The spark lever should be fully advanced. The governor should control the speedometer speed to 23 to 27 mph.

(*j*) Regulate the voltage with the field rheostat to 100 volts.

(*k*) When the engine has been warmed up, close circuit breaker on power panel.

(*l*) Close switch to start rotary converter.

Q. How would you adjust the voltage and current? *A.*

(1) *Sperry M1940 and M1941, and General Electric M1940.*—With the engine speed set to 1,000 rpm for Sperry M1940, 1,100 rpm for Sperry M1941, or 1,200 rpm for General Electric M1940 under arc load condition, the following procedure should be observed:

(*a*) With the searchlight arc burning, adjust the voltage regulating rheostat so that the ammeter *at the searchlight* indicates the proper arc

current, approximately 150 amperes. The voltmeter at the power plant should then indicate approximately 100 volts and the ammeter at the power plant should indicate approximately 162 amperes (160 amperes on the General Electric M1940).

(*b*) Voltage and current adjustment should be made with the arc load "on."

(2) *Sperry M1937 and M1939.*—The governor and generator voltage control equipment has two operating positions, listening load and arc load. Therefore two separate rheostats are provided.

(*a*) At listening load speed (875 to 900 rpm) the listening load rheostat should be adjusted so that the generator delivers 10 to 15 amperes at 100 to 110 volts.

(*b*) At arc load speed (1,200 rpm) the arc load rheostat should be adjusted so that the generator delivers 165 amperes at 100 volts.

(3) *M1934 portable.*—(*a*) Set the "voltage manual" rheostat on the painted marks. This rheostat controls the voltage directly when the voltage regulator and electrical governor are disconnected. Under automatic operation, the proper setting of this rheostat is necessary so that the engine will run at the proper speed while generating the proper voltage.

(*b*) Set the "voltage automatic" rheostat on the painted marks. This rheostat provides a fine adjustment of the voltage by changing the setting of the voltage regulator.

(*c*) With the rheostats set on the painted marks as indicated, the generator should develop approximately 100 volts at approximately 850 rpm with a hot engine. If this operating condition is obtained, it will indicate that the electrical governor is functioning. It may be necessary to shift the rheostat settings very slightly to obtain the above desired values. After these settings are made, no further adjustments of the rheostats will normally be required while operating the searchlight.

(4) *M1934 mobile.*—The M1934 mobile power plant has incorporated in it an automatic voltage regulator which maintains approximately constant voltage regardless of current fluctuations. The desired voltage is set by the voltage adjustment rheostat, located on the upper right hand side of the control panel. The knob of the rheostat is turned clockwise to increase the voltage and counterclockwise to decrease the voltage. The normal operating voltages are 98 volts with 150 amperes arc load, and 101 volts with a listening load speed of 900 rpm.

(5) *M–VI.*—With the searchlight in operation, and the power plant running at a speedometer speed of 25 mph, adjust the generator field

rheostat so that the voltage of the generator is 100 volts. The ammeter should then indicate approximately 150 amperes.

Q. In case of an emergency, how would you manually control the engine speed and voltage? *A*.

(1) *Sperry M1941 and M1940, and General Electric M1940*.—(*a*) The first precaution is to make certain that the governor arm is blocked (tied) in the forward position to prevent interference from the governor itself.

(*b*) With throttle adjusted to a setting of approximately normal arc-load speed, start engine, allow it to warm up, and then strike the arc. Adjust the throttle until the tachometer indicates normal arc-load speed with the arc burning.

(*c*) If required, adjust the voltage regulating rheostat until the ammeter indicates the proper current.

(*d*) When the arc is cut off, the throttle at the power plant must be immediately readjusted to prevent overspeeding and excessively high voltages.

NOTE:—Do not readjust the voltage regulating rheostat after it has once been adjusted for arc load.

(2) *Sperry M1937 and M1939*.—(*a*) Block the governor arm in the forward position (tie it) to prevent interference from the governor.

(*b*) Set the throttle at listening speed. When the arc is struck, adjust the throttle to obtain the normal arc-load speed.

(*c*) When changing from arc load to listening load, quickly push in the throttle simultaneously with the removal of arc load to decrease engine speed. This must be done to avoid overspeeding and excessively high voltage.

(*d*) If engine speed adjustments are carefully made it will be unnecessary to change settings of listening-load rheostat or arc-load rheostat when changing from one speed to the other.

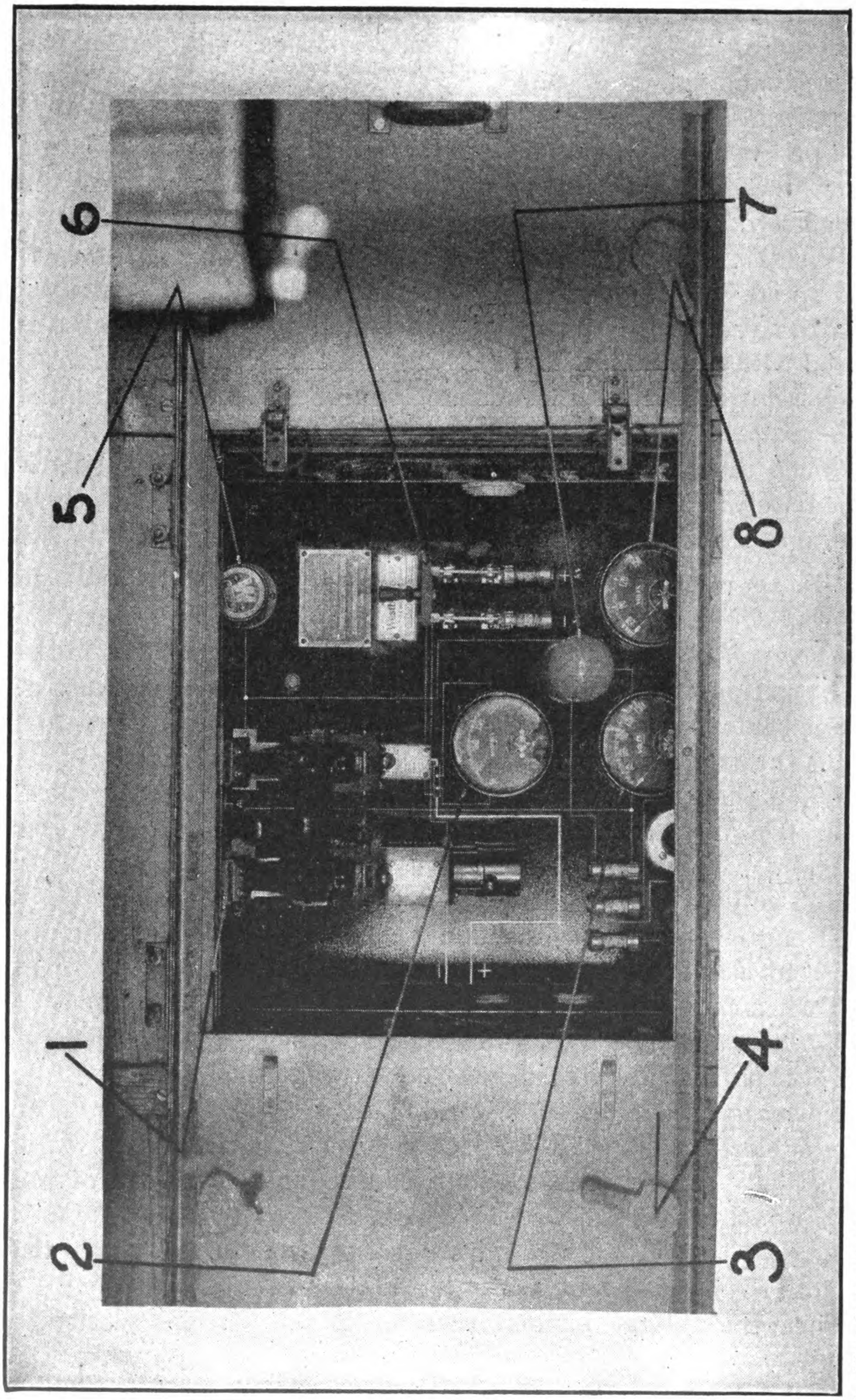
(3) *M1934 portable*.—The voltage and speed may be manually controlled should the electrical governor or regulator fail.

(*a*) Normally on failures or opening of the electrical governor circuit, the electrical throttle will return to and remain at the wide open position. If this does not happen disconnect one lead of the voltage automatic rheostat.

(*b*) Release the mechanical governor thumb nuts to permit the rod to go to the limit of its travel into the panel.

(*c*) Turn the voltage manual rheostat to the extreme clockwise position.

(*d*) Pull out the mechanical governor rod and lock it at the no-load speed of 1,150 rpm.



1. Circuit breaker.
2. D-c ammeter.
3. D-c voltmeter.
4. Sliding door.
5. Generator field rheostat.
6. A-c switch for rotary converter.
7. Lamp.
8. A-c voltmeter.

FIGURE 118.—Power panel (control panel) M–VI (duplex truck).

(*e*) Adjust the voltage manual rheostat until the no-load voltage is 110 volts.

(*f*) When the arc is struck, adjust the voltage manual rheostat to 98 volts when searchlight arc is drawing 150 amperes.

(*g*) When changing from arc load to listening load, quickly readjust the voltage manual rheostat to 110 volts.

(*h*) If the voltage regulator fails, remove the front of the panel and block regulator in the closed position. The engine speed may then be adjusted and maintained approximately correct by manual control of the throttle. When the arc load is removed, immediately push in the throttle to decrease engine speed in order to prevent overspeeding and excessively high voltages.

(4) *M–VI.*—(*a*) Block the governor arm (tie it) so that the butterfly valve on the carburetor is in the open position.

(*b*) The engine speed may then be adjusted and maintained approximately correct by manual control of the throttle.

(*c*) When the arc load is removed, immediately push in the throttle to decrease the engine speed in order to prevent overspeeding and excessively high voltages.

Q. What should you do if the governor rod or governor arm should break? *A.* Wire the valve lever that goes to the carburetor so as to hold the butterfly control valve in the *open* position. The power plant may then be manually controlled.

Q. How would you stop the power plant? *A.*

(1) *Sperry M1937, M1939, M1940, and M1941, and General Electric M1940.*—(*a*) Throw main switch (21) to the "off" position.

(*b*) Push the throttle all the way in to allow the engine to slow down to idling speed.

(*c*) Turn ignition switch (35) to "off" position. If the ignition switch is turned off before engine has slowed down to idling speed, it will backfire and probably damage the exhaust stack or muffler, or both.

(2) *Sperry M1934 portable.*—(*a*) Open the main circuit breaker.

(*b*) Turn off ignition switch.

(3) *M1934 mobile.*—(*a*) Open main circuit breaker.

(*b*) Close the throttle.

(*c*) Disengage the clutch.

(*d*) Put the truck transmission gear shift lever in neutral.

(*e*) Move generator clutch lever to truck position and fasten it with safety chain.

(*f*) Remove foot from clutch.

(*g*) Open auxiliary circuit breaker.

(*h*) Close the generator ventilating covers.

72. Operation.—*Q*. What three main items should the operator check before starting the power plant? *A*.

(1) Cooling liquid in radiator.

(2) Oil in crankcase.

(3) Gasoline supply.

(4) *M-VI*.—(*a*) Open the circuit breaker.

(*b*) Decelerate the engine by gradually closing the hand throttle.

(*c*) Pull out the governor cut-out button on the dash.

(*d*) Depress the engine clutch and place the gear shift in neutral.

(*e*) If the power plant is not to be operated again immediately, the operator should then shift the generator clutch lever to its forward position, open the contact to the second muffler, stop the engine, lower and clamp the covers on the engine hood, and lower and clamp the generator port covers.

73. Care of power generator.—*Q*. Should mechanisms and bearings be overlubricated? *A*. No. Never overlubricate as it may cause much trouble, especially around electrical apparatus.

Q. Is more grease required in the Tropics than in cold climates? *A*. Yes. However, be careful not to overlubricate.

Q. Should the commutator be lubricated? *A*. No. The brushes contain sufficient graphite to maintain proper lubrication.

Q. How are the generator bearings lubricated? *A*.

(1) *Sperry M1937, M1939, M1940, and M1941*.—The armature is supported at the commutator end by a sealed or cartridge type of ball bearing. The grease is provided in the bearing at the factory and will give adequate lubrication for 3 years of normal service. It is recommended that when the engine is reconditioned the grease in this bearing should be examined; if the grease is discolored or has a bad odor, the bearing should be cleaned and repacked with new ball-bearing grease of the type furnished for this purpose. Be very careful not to overlubricate.

(2) *General Electric M1940 and Sperry M1934 portable*.—The bearing at the commutator end is provided with a grease cup. A soft grade of grease should be used. Be careful not to overlubricate, because the bearing will overheat and the grease may leak past the seal into the generator. The amount of grease added must be determined by experience.

(3) *M1943 mobile and M-VI*.—There are three distinct rotating members included in the generator: armature, propellor shaft, and tail shaft. Each of these units is supported on two antifriction

bearings. The bearings for the armature and propellor shaft at the commutator end should be lubricated with a soft grease by means of the fittings provided. Be careful not to overlubricate. The remaining bearings are lubricated with oil (SAE No. 70) from the clutch housing.

74. **Care of engine.**—*Q*. How can the amount of oil in the crankcase be determined? *A*. By means of an "oil gage rod" or "dip stick."

Q. What oil should be used? *A*. In summer, SAE No. 30 is recommended for normal operation. For heavy-duty operation in summer, SAE No. 40 may be used. In winter, use SAE No. 10W. (All Navy specifications.)

Q. Why should the filler cap be on the filler pipe at all times, except when refilling the engine with oil? *A*. With the filler pipe open, the breathing action of the engine will draw dust and dirt into the engine, causing rapid wearing of the cylinder walls and bearing surfaces.

Q. How often should valves be ground and carbon cleaned from the engine? *A*. If instructions as given are followed carefully, the valves will seldom require grinding and little carbon will be formed. *Watch the oil and gasoline for impurities.*

Q. How often should the oil pan be removed? *A*. Every 6 months so that the oil screen may be cleaned.

Q. Should the carburetor be adjusted frequently? *A*. No. Very often the trouble is caused by dirty gasoline or by water in the gasoline.

Q. How often should the gasoline filter be cleaned? *A*. Whenever there is any sediment present, or when there is a noticeable amount of water in the glass bowl of the filter.

Q. Should the distributor points be checked? *A*. Yes. Check frequently to see that they are clean and making good contact without unnecessary sparking. If pitted, clean with No. 00 sandpaper.

Q. How often should the radiator be cleaned? *A*. At least twice a year, usually in the spring and in the fall. Use ½ pound sal soda and ½ pint kerosene per gallon of water. Fill the radiator with this solution and run the engine for 3 or 4 hours, then flush out thoroughly with clear water, using at least two changes of clear water before filling the radiator for normal operation.

Q. Where can you find instructions for adjusting the various parts, replacements, and trouble shooting? *A*. Refer to the Operator's Manual furnished with your power plant. *Follow instructions exactly.*

LUBRICATION SCHEDULE M1939
(Main parts of searchlight power plants)

	Sperry M1940, M1941	General Electric M1940	Sperry M1937	Portable M1934	Mobile M1934 and M-VI
ENGINE					
Engine oil change	Every 3 months, or every 30,000 "hundreds" revolutions of the engine.				1,000 miles.
Chassis	3 months	3 months	3 months	3 months	Do.
Fan bearings	6 months	6 months	6 months	6 months	Do.
Water pump	Weekly	Weekly	Weekly	Weekly	Do.
Governor and throttle linkages	do	do	do	do	Do.
Sidedoor hinges	do	do	do	do	
Carburetor	do	do	do	do	1,000 miles.
Charging generator	Monthly	Monthly	Monthly	Monthly	Do.
Starting motor	do	do	do	do	Do.
Distributor	do	do	do	do	Do.
Magneto			Yearly	Yearly	
Electrical governor				2 months	
Trailer				1,000 miles	
GENERATOR					
Main bearing	3 years	Monthly	Monthly	Monthly	5,000 miles.
Tachometer drive	3 months	3 months	3 months	3 months	

MAINTENANCE SCHEDULE

	Sperry M1940, M1941	General Electric M1940	Sperry M1937	Portable M1934	Mobile M1934 and M-VI
ENGINE					
Air cleaner	Weekly	Weekly	Weekly	Weekly	1,000 miles.
Oil filter, renewed	When black streaks begin to appear in the oil				Clean every 1,000 miles.
Oil screen, cleaned	6 months	6 months	6 months	6 months	
Radiator, cleaned	do	do	do	do	5,000 to 10,000 miles.
Fan motor cleaned	3 months		3 months	3 months	
Battery	Weekly	Weekly	Weekly	Weekly	Weekly.
Distributor points	Monthly	Monthly	Monthly	Monthly	Monthly.
Magneto			do	do	
GENERATOR					
Cleaned	3 months	3 months	3 months	3 months	3 months.
Brushes, checked	do	do	do	do	Do.

NOTE.—Above schedule is based on normal or average conditions; in some cases more frequent maintenance and lubrication may be necessary, as will be determined by experience. For detailed maintenance and lubrication consult the Operators Manual furnished with each power plant.

SECTION VIII

CARE AND OPERATION OF SEACOAST SEARCHLIGHT POWER PLANT

75. Fixed seacoast searchlight power plant.—*Q*. What is the standard power unit for harbor defense searchlights? *A*. The 25-kw gasoline electric generating set, type GM 12.

Q. What other power units are sometimes used? *A*. Some of the more modern fortifications use 90- to 200-kw Diesel-driven generating plants, while others are furnished motor-generators driven by commercial alternating current power.

Q. Name and point out the principal parts of the 25-kw gasoline electric set, type GM 12. *A*.

(1) The gasoline engine which drives the electric generator.
(2) The electric generator which supplies the electrical power.
(3) The cooling fan which cools the water for the gasoline engine.

Q. Describe the gasoline engine. *A*. Heavy duty, four cylinder, water-cooled, high-tension magneto ignition with impulse starter; compression release lever to make cranking easier; a centrifugal governor operating on the throttle valve to maintain a normal speed of 560 revolutions per minute; combination force and splash feed lubrication from a 5-gallon oil reservoir in bottom of crank case; water is cooled by flowing through a radiator which is mounted in front of an electrically driven fan.

Q. Describe the generator. *A*. 115-volt, d-c, 27-kw (2-kw for cooling fan motor).

Q. How do you start the gasoline engine? *A*.

(1) Check water and oil supply.
(2) Fill carburetor by hand pump.
(3) Release compression.
(4) Turn ignition off.
(5) Close air valve completely.
(6) Open needle valve one to four turns (individual sets differ).
(7) Turn flywheel two revolutions.
(8) Open air valve two notches.
(9) Turn ignition on and retard magneto.
(10) Turn flywheel and engine should start.
(11) Open air valve fully.
(12) Throw on compression.

(13) Advance magneto.

(14) Adjust needle valve after engine warms up.

Q. Why should excessive priming be avoided prior to or during the starting of the engine? *A*. Explosions in the crank case and fires from backfiring through the carburetor have been known to occur as a result of such practice. The results are serious.

Q. How should water circulation be tested? *A*. Open the waste cock beneath the gage in the water outlet from the exhaust manifold. Leave it open until water flows freely. This should occur within about 20 seconds after starting.

Q. What is the maximum allowable temperature of water leaving the cylinder jackets? *A*. 90° C.

Q. Under normal conditions of running, how can water temperature be controlled? *A*. By varying the speed of the fan. This is accomplished by use of the short circuiting switch on the switchboard which reads "Close when jacket water exceeds 90° C."

Q. How is jacket water temperature measured? *A*. By a thermometer placed in cup filled with oil at the exhaust water outlet.

Q. What are some common troubles and their causes? *A*.

Trouble	Cause
Hard to start	(1) Dirty plugs. (2) Spark gap in plug not properly set. (3) Broken plug insulator or punctured high-tension lead. (4) Wiring connections not rigid. (5) Poor gasoline mixture. (6) Cold weather. (7) Excessive priming.
Knocking	(1) Spark too far advanced for load. (2) One cylinder not firing, others therefore overloaded. (3) Preignition, caused by too rich or too lean mixture or by carbon in cylinders. (4) Loose bearings.
Overheating	(1) Water circulation faulty. (2) Fan stopped. (3) Improper mixture. (4) Spark retarded too much. (5) Insufficient lubrication.

Trouble	Cause
Poor regulation----------	(1) One or more cylinders not firing, manifested by periodic swing in voltage. (2) Sticky governor or dashpot. (3) Sticky or dirty throttle valve. (4) Gasoline needle valve clogged.

Q. Describe the care of the power unit. *A.*

(1) Keep oil level of the gasoline engine up to the mark on the sight gage. This should be checked when engine is not running.

(2) Renew lubricating oil, after about 500 hours of operation, with 5 gallons of oil specified for that purpose.

(3) Oil pressure gages should read between "10" and "15."

(4) Oil governor, gas pump plunger, and fan motor every 10 hours while running.

(5) Do not place oil in governor dash pot.

(6) Grease cups of water pump and eccentric strap should be turned down every 8 hours while running.

(7) Cooling water should not exceed a temperature of 90° C. A pressure gage and waste cock should be installed near exhaust manifold.

(8) Do not use the electric air heater for carburetor on account of the fire hazard.

(9) Take care to avoid freezing of cooling water.

(10) Do not use cartridge starter.

(11) Outboard bearing of generator should be filled with thin lubricating oil.

(12) Commutator of generator should be wiped occasionally with a piece of canvas lightly coated with vaseline.

(13) Clean oil strainers every 500 hours of operation.

(14) Clean up any oil or gasoline spilled around power plant to reduce fire hazard.

Q. Where can you find detailed instructions for the care and operation of this power plant? *A.* Instruction Book No. 1, "Instruction, Care, and Operation of the 25-kw. gasoline electric generating sets, General Electric Co., type GM-12, Engineer Department, U. S. Army, 1916."

76. Mobile seacoast searchlight power plant.—This power plant is identical in care and operation with the antiaircraft searchlight power plant. (See appropriate paragraph as to type in sec. VII.)

SECTION IX

CARE AND OPERATION OF ANTIAIRCRAFT SEARCHLIGHT

77. Searchlights, general.—*Q*. How is the power transmitted from the power plant to the searchlight? *A*. Through two single-conductor cables.

Q. How are these cables identified? *A*. The plugs and receptacles are painted yellow.

Q. What is the normal current and voltage of the arc? *A*. The arc should operate with a current of 150 amperes and a voltage of 78 volts.

Q. What is the relation between the arc length, arc voltage, and arc current? *A*.

(1) The arc voltage varies directly as the arc length. That is, the arc voltage decreases as the arc length becomes shorter.

(2) The arc current varies inversely as the arc length. That is, the arc current increases as the arc length becomes shorter.

Q. What are the dimensions and burning time of the carbons? *A*.

Carbon	*Size*	*Burning time (approximate)*
Positive	22 inches by 0.633 inches outside diameter	1½ hours
Negative	12 inches by 0.434 inches outside diameter	1½ hours

Q. When recarboning should you use new carbons? *A*. Yes, always use a pair of full length carbons.

Q. Before entering the drum what should you do? *A*. Make sure that the arc switch is open. In the Sperry M1941 light be sure that the recarboning safety switch has been thrown to the "recarboning" position.

Q. How should the carbons be protected? *A*. Keep the carbons dry and protect them against jarring that might crack the carbons or their cores.

Q. How is the mirror cleaned? *A*. The mirror surface is of precious metal, and great care should be taken in cleaning it. The mirror should be cleaned with the solution supplied for that purpose. Use only dry cotton pads for applying and for wiping off the solu-

tion. Before using the solution, remove any dust with a soft camel's-hair brush. Never clean the mirror with a rotary motion; always pass the pad over the mirror surface from the center toward the edge. Since the cleaning solution contains ammonia, the drum should be well ventilated while the solution is being used.

78. Sperry searchlights.—*a. Operation and care.*—*Q.* In what two ways can the arc be struck? *A.* Automatically or manually.

Q. Describe each briefly. *A.*

(1) *Automatically.*—With the lamp control mechanism set for automatic operation, close the arc switch. The negative carbon will automatically strike the arc and maintain the proper arc length.

(2) *Manually.*—First, centralize the negative feed pawls by moving the negative feed centralizer lever (or knob) to the hand position. This will allow feeding of the negative carbon by hand. Second, move the negative carbon forward by means of the negative hand feed knob. Third, after striking the arc, retract the negative carbon until the voltmeter reads approximately 78 volts.

Q. In the M1941 Sperry light what automatic provision is made to strike the arc quickly? *A.* The arc switch incorporates an additional switch known as a thermal operated circuit breaker. This circuit breaker is designed to close 5 to 7 seconds after the main arc switch is opened. The closing of the circuit breaker causes the negative carbon to feed forward rapidly, attempting to strike a new arc. When the carbons touch, a "short circuit" condition is caused which opens the circuit breaker and prevents the restriking of the arc. Thus the negative carbon is left in contact with the positive carbon and is in position for a quick strike of the arc.

Q. How would you insert a new positive carbon? *A.* Spread the feed roller brackets apart by means of the recarboning key. Insert the new carbon until it projects $^{13}/_{16}$ of an inch beyond the positive nose cap. Turn the recarboning key slowly until it permits the positive rollers to grip the carbons.

Q. Explain the recarboning of the negative head. *A.* Push the lower end of the negative carbon release lever toward the positive head so that the negative carbon may be readily inserted through the rear of the head. Move carbon in until it projects approximately 1 inch beyond the negative nose cap. Return the release lever slowly to its normal position. Never allow the lever to snap back as this may break the negative carbon.

Q. What is the purpose of the thermostat? *A.* The positive carbon burns back twice as fast as the normal rate of feed, therefore, the thermostat functions to give the positive carbon an additional

forward feeding to keep the luminous ball of vapor at the focal point of the mirror.

Q. How does the thermostat function? *A*. It is a thin strip of two different metals welded into a single strip. When heated this strip will bend because the two metals have different rates of expansion. When the positive carbon burns faster than the rate of feeding, the positive crater moves back from the focal point of the mirror until rays of light from the positive crater are focused by the thermostat lens (26) on to the bimetallic strip. The strip bends and closes an electrical contact which in turn energizes the positive feed electromagnet causing the positive carbon to be fed forward rapidly until the positive crater has returned to the focal point.

Q. How could you operate the searchlight if the thermostat or the positive control electromagnet failed? *A*.

(1) *Sperry M1941*.—Turn the positive feed rate adjustment screw approximately one and one-fourth turns counterclockwise toward "Semi." The position of the positive carbon should be carefully watched to keep it at the focal center. The positive carbon can be fed forward by depressing the positive hand feed lever whenever the positive carbon is behind the focal point.

(2) *Sperry M1940*, *M1939*, *M1937*, *M1934*, *M–VI*.—Turn the positive feed rate adjusting knob (23) counterclockwise toward "Semi." The positive carbon will feed forward at a rate so as approximately to position the positive crater at the focal point. Because of the absence of automatic control, the position of the carbon should be watched carefully through the ground glass view finder to prevent over or under feeding.

Q. What is the function of the arc length control coil (23)? *A*. It acts as a magnet on armature (35), which in turn positions negative feed pawl guard (6), allowing ratchet (5) to retract the negative carbon when the arc voltage is less than 78 volts. Rachet (7) is engaged when the voltage is greater than 78 volts. Thus it keeps the negative carbon positioned so as to maintain a constant arc length. It functions on the principle that the arc voltage varies directly with the arc length.

Q. How could you operate the searchlight if the arc length control coil should fail? *A*. Set the negative feed centralizer lever or knob to "hand" position and turn the negative hand feed knob so as to maintain the required searchlight voltage of 78 volts.

Q. How is the interior of the lamp drum kept cool during operation? *A*. There is a small motor-driven fan on top of the searchlight

drum which draws air from openings at the bottom and side of the searchlight and exhausts the hot gases out through the top.

Q. Should coarse sandpaper ever be used on the searchlight? *A*. *No*. Unless otherwise specified use No. 00 sandpaper whenever an abrasive is required for cleaning this equipment.

Q. How often should the negative head contact surfaces be cleaned? *A*. After every *third* change of carbons. Wrap a piece of No. 00 sandpaper around a negative carbon stub and work it back and forth in the negative head. Clean all abrasive materials from the surfaces.

Q. How often should the positive carbon contact surface be cleaned? *A*. After every *tenth* change of carbons.. The brushes must be removed. Then with No. 00 sandpaper around a positive carbon stub move it back and forth between the two brushes. Wipe off all dust.

Q. Should the carbon contact surfaces ever be reamed out? *A*. Only in extreme circumstances.

Q. What lubrication is necessary after every 10 hours of operation? *A*. If the lamp has been lubricated with a graphite and oil mixture, place a few drops of a mixture of machine oil and kerosene on the bearings and gears of the lamp mechanism. If the lubricant Aquadag has been used this is not necessary.

Q. What cleaning and lubrication of the lamp mechanism are necessary after every 50 hours of operation? *A*. If Aquadag has been used, no cleaning is necessary. In any case, at periods of 2 months, the entire lamp mechanism must be washed thoroughly with gasoline with the exception of the positive drive pinion bearing, the main positive feed bearing, and the roller bearing in the semifixed gear (all ball and roller bearings). Aquadag may be used as a lubricant. When Aquadag is used, apply with a spray gun when the lamp head is *hot*.

Q. What else should be lubricated every 50 hours of operation (or every 2 months)? A.

(1) The ventilating motor bearings (accessible after removing the ventilating motor fan housing) should have a small amount of medium motor oil at the time the motor is inspected (once every 3 months).

(2) Feed motor bearings should be oiled and the feed motor worm gear should be greased with a high temperature grease every 3 months.

(3) The feed mechanism ball bearings must be oiled with light machine oil from inside the drum.

(4) All alemite fittings must be greased at least once a month.

(5) Azimuth and elevation control (training) motors must be oiled once a month with medium oil.

Q. How is the thermostat cleaned? *A.*

(1) Remove the thermostat from the searchlight drum and place it on a suitable flat surface, preferably a workbench.

(2) Remove the four cover screws and cover.

(3) Unscrew the contact assembly holding screws and remove the contact assembly.

(4) Clean the points with crocus paper, being careful not to bend the contact arms and to avoid execssive rubbing with the abrasive.

(5) When finished cleaning, draw a piece of white paper between the contacts to wipe off any abrasive that may be left on the points.

(6) Reassemble the thermostat and replace it in its position in the drum.

Q. How are the supply and control slip rings cleaned? *A.* Access to these rings may be had through the handhole plate in the top of the base of the searchlight. The rings should be cleaned with alcohol whenever necessary, and at least once every 3 months. Use No. 00 sandpaper, if necessary, to clean any burned spots.

Q. How are the motor brushes cleaned? *A.* After every 50 hours of operation remove the brushes and wash them in gasoline. Wash each brush and replace in its original position. Make sure that the brushes slide freely in their holders.

Q. How, and when, should the time delay mechanism of the M1941 searchlight be lubricated? *A.* It should be lubricated with light machine oil at intervals as determined by inspection.

b. Sperry searchlight, M1941.—*Q.* Describe briefly the operation of the lamp control mechanism. *A.* The lamp control mechanism and lamp are shown in schematic form in figure 119.

(1) *Positive carbon feed system.*—The feed motor (30) drives, through a set of gears, the positive rod (16), which drives miter gear (188) and a driven miter gear. Miter gear (189) drives a yoke carrying with it a set of gears. This set of gears includes a ratchet and gear assembly (190) which, when prevented from rotating by a feed plunger (191), causes a planetary gear (206) to rotate, which in turn causes the feed rollers to rotate, thus feeding the positive carbon forward.

(2) *Negative carbon feed system.*—The negative carbon feed system operates as follows: The feed motor (30) drives through eccentric gear (186), which in turn causes the reciprocating feed member (29) and the feed pawls (4) to oscillate back and forth. One of the feed pawls (4) (depending upon the position of the negative feed con-

trol guard (6)) drives the negative control rod (3) so as to feed the negative carbon forward. The other pawl (4) drives the control rod in the opposite direction so as to retract the negative carbon. The negative control rod (3) is connected to the feed rollers which position the negative carbon.

Q. What operates the positive feed plunger (191), figure 119? *A*. An electromagnet which may be energized from two sources: a cam operated switch (195) or thermostat (25).

c. Sperry searchlight, M1940 (M1934, M1937, M1939, and M-VI are similar).—*Q*. Describe briefly the operation of the lamp control mechanism. *A*. The control mechanism and lamp are shown in schematic form in figure 120.

(1) *Positive carbon feed system.*—The feed motor (30) drives an eccentric disk (34) causing the reciprocating feed member (29) and positive feed pawl (20) to move back and forth. Positive feed pawl (20) engages the teeth on positive feed ratchet (18), rotating it and the positive control rod (16) in a counterclockwise direction. Control rod (16) drives gear (36) causing a yoke carrying planetary gear (38) to rotate. Planetary gear (38), through a worm drive, causes the carbon feed rollers to rotate and feed the positive carbon forward.

(2) *Negative carbon feed system.*—The reciprocating feed member (29) and the feed pawls (4) oscillate back and forth. One of the feed pawls (4) (depending upon the position of the negative feed control guard (6)) drives the negative control rod (3) so as to feed the negative carbon forward. The other pawl (4) drives the control rod in the opposite direction so as to retract the negative carbon. The negative control rod (3) is connected to the feed rollers which position the negative carbon.

Q. What is the function of the positive feed control guard (19)? *A*. Raising the positive feed control guard permits more teeth on the positive feed ratchet (18) to be engaged by positive feed pawl (20), thereby increasing the rate of feeding of the positive carbon. The opposite condition occurs when the guard (19) is lowered. The normal position of the positive feed control guard (19) is such as to allow the positive feed pawl (20) to engage only one tooth on the positive feed ratchet (18) for each stroke of the feed pawl.

Q. What actuates the positive feed control guard (19)? *A*. The positive feed control guard can be positioned automatically or manually as follows:

(1) *Manually.*—By turning the positive feed rate adjustment knob (23), the position of the positive feed control guard (19) can be controlled, and therefore the rate of feeding of the positive carbon.

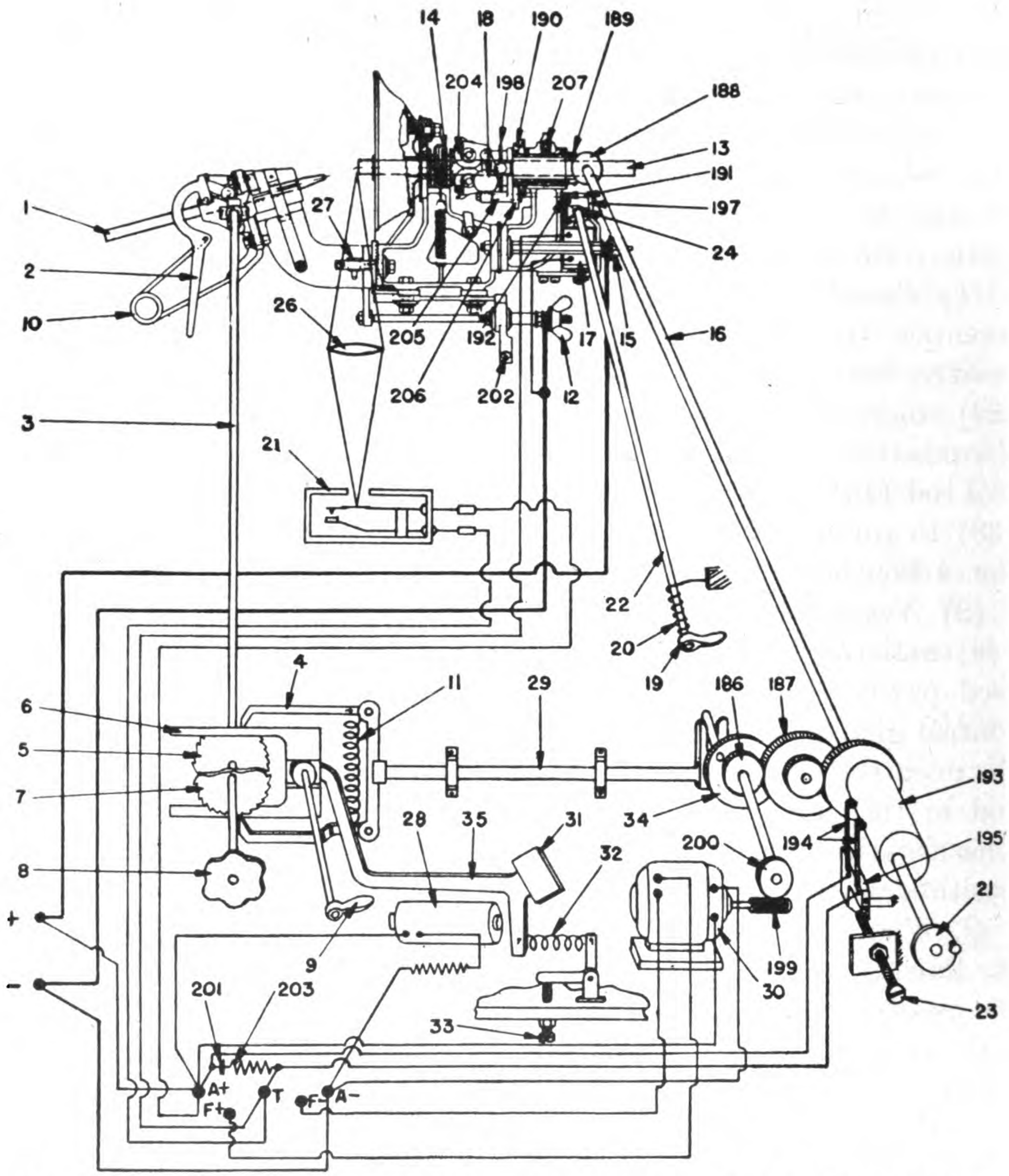


FIGURE 119.—Schematic diagram of Sperry M1941 lamp and lamp control mechanism.

1.	Negative carbon.	29.	Reciprocating feed member.
2.	Negative release lever.	30.	Feed motor.
3.	Negative control rod.	31.	Counterbalance.
4.	Negative feed pawls.	32.	Adjustment spring.
5.	Negative feed back ratchet.	33.	Arc length adjustment screw.
6.	Pawl guards controlling negative feed.	34.	Eccentric disk.
7.	Negative feed forward ratchet.	35.	Balanced armature.
8.	Negative hand feed knob.	186.	Eccentric shaft gear.
9.	Negative feed centralizer lever.	187.	Gear train.
10.	Negative carbon release spring.	188.	Driving miter gear.
11.	Negative feed pawl spring.	189.	Driven miter gear.
12.	Negative terminal.	190.	Ratchet and positive feed gear assembly.
13.	Positive carbon.	191.	Spring loaded feed plunger.
14.	Positive contact.	192.	Plunger spring.
15.	Positive terminal.	193.	Eccentric cam.
16.	Positive control rod.	194.	Roller arm contacts.
17.	Positive feed control electromagnet.	195.	Switch.
18.	Positive feed gear.	197.	Plunger operating armature.
19.	Positive hand feed lever.	198.	Recarboning key.
20.	Positive hand feed lever spring.	199.	Worm.
21.	Positive hand feed handwheel.	200.	Worm wheel.
22.	Positive feed shaft.	201.	Condenser.
23.	Positive feed rate adjustment screw.	202.	Focusing bracket set screw.
24.	Positive feed shaft pin and spring.	203.	Resistor.
25.	Thermostat.	204.	Positive carbon feed rollers.
26.	Thermostat lens.	205.	Yoke.
27.	Lens positioning screw.	206.	Planetary gear.
28.	Arc length control coil.	207.	Main positive feed bearing.

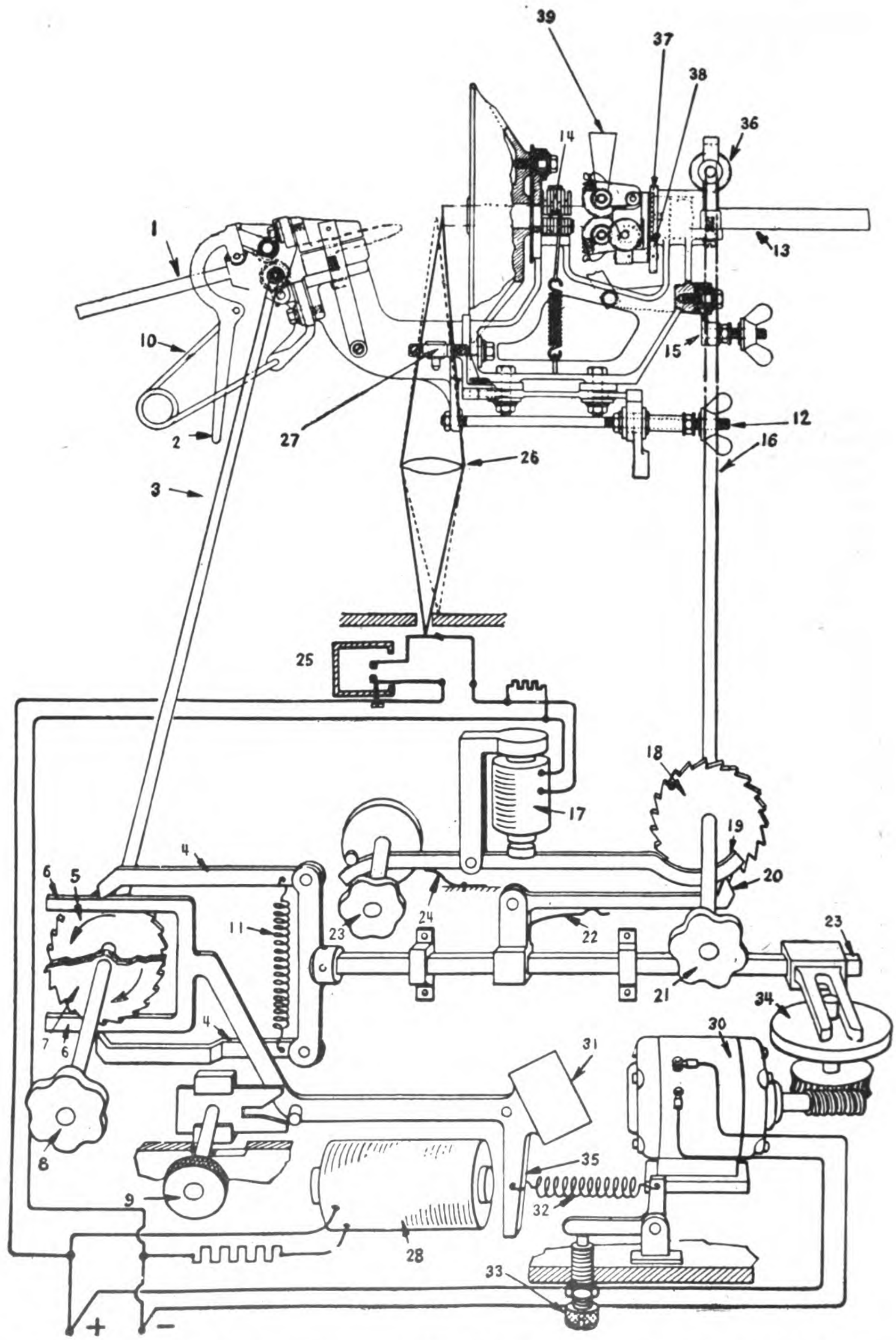


FIGURE 120.—Schematic diagram of Sperry M1940 lamp and lamp control mechanism.

1. Negative carbon.
2. Negative release lever.
3. Negative control rod.
4. Negative feed pawls.
5. Negative feedback ratchet.
6. Pawl guards controlling negative feed.
7. Negative feed forward ratchet.
8. Negative hand feed knob.
9. Negative feed centralizer knob—for hand feed.
10. Negative carbon release spring.
11. Negative feed pawl spring.
12. Negative terminal.
13. Positive carbon.
14. Positive contact.
15. Positive terminal.
16. Positive control rod.
17. Positive feed control electromagnet.
18. Positive feed ratchet.
19. Positive feed control guard.
20. Positive feed pawl.
21. Positive hand feed knob.
22. Positive feed pawl spring.
23. Positive feed rate adjustment knob.
24. Positive feed electromagnet spring.
25. Thermostat.
26. Thermostat lens.
27. Lens positioning screw.
28. Arc length control coil.
29. Reciprocating feed member.
30. Feed motor.
31. Counterbalance.
32. Adjustment spring.
33. Arc length adjustment screw.
34. Eccentric disk.
35. Balanced armature.
36. Gear.
37. Fixed gear.
38. Planetary gear.
39. Recarboning wrench (shown in position for recarboning only).

(2) *Automatically.*—The positive feed control electromagnet, when energized, will raise the positive feed control guard (19), thereby increasing the feeding of the positive carbon.

Q. What energizes the positive feed control electromagnet (17)? *A.* The closing of the contacts of the bimetallic strip in the thermostat (25).

79. General Electric searchlight M1940.—*a. Operation.*—*Q.* Describe briefly the operation of the General Electric lamp mechanism. *A.*

(1) *Positive feed.*—See figure 121. The lamp motor, through a set of gearing and shafts, drives a helical gear on the positive head, which transmits a constant rotary motion to the yoke and positive carbon. When the detent is not engaged with the detent gear, the entire assembly, including the spur gear, rotates with the yoke. When the detent is engaged with the detent gear, the spur gear attached to the detent wheel is kept from rotating, causing the outside gear to rotate around the attached spur gear, thereby causing the feed rollers, through a worm drive, to feed the positive carbon forward.

(2) *Negative feed.*—The lamp motor, through a set of bevel gears, rotates the negative drive shaft. Mounted on and keyed to this shaft is a "sliding-armature friction driver" which rotates with, but is free to slide along, the shaft. On each end of the sliding-armature friction driver is a friction collar, either of which by proper positioning of the sliding-armature can drive a friction driven disk. This friction-driven disk is connected by shafting and gearing to the negative feed pawls. Positioning of the sliding-armature friction driver is controlled by two stationary electromagnets, each of which is built around one of the friction collars. One of these electromagnets is termed the "feed coil" and the other is termed the "retract coil." When the feed coil is energized, the sliding-armature friction driver is positioned so that the friction-driven disk is rotated in the proper direction to cause the feed rollers to feed the negative carbon forward. When the retract coil is energized, the direction of rotation of the friction-driven disk is reversed and the negative carbon is retracted.

Q. What actuates the detent? *A.* The positive feed magnet, when energized, causes an armature to turn; this turns a shaft which causes the detent to engage the detent gear. This armature may also be actuated manually by pushing the "manual positive feed."

Q. How is the positive feed magnet energized? *A.* It may be energized from two sources:

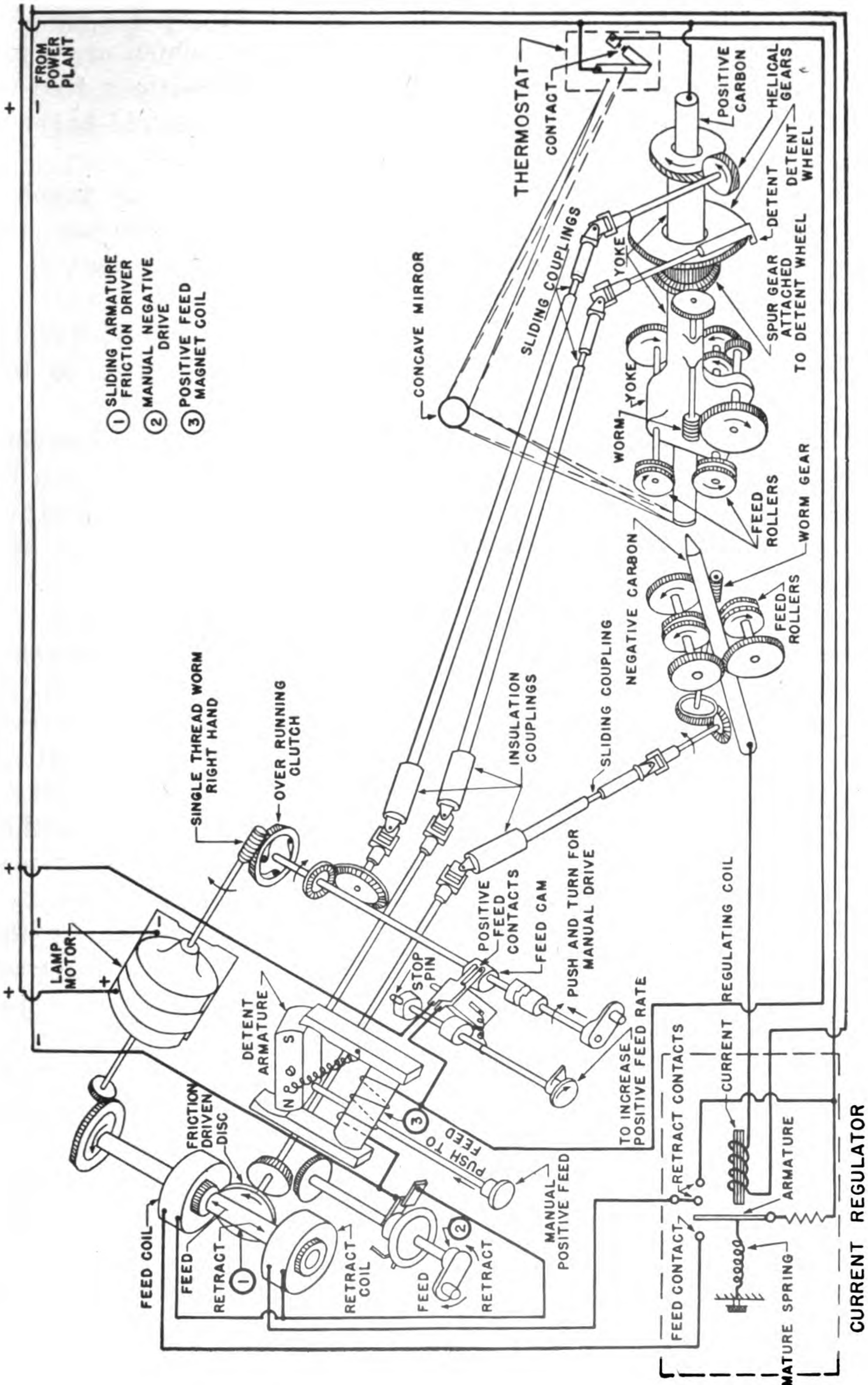


FIGURE 121.—Schematic diagram of General Electric lamp control mechanism and lamp mechanism.

(1) By the thermostat, whenever the positive carbon burns back from the focal point of the mirror.

(2) By the closing of the positive feed contacts which are actuated by rotation of a cam. This provides an intermittent feed to the positive carbon which is somewhat less than the rate of burning of the positive carbon.

Q. Can the positive feed rate be adjusted? *A.* Yes, by turning the manual positive feed adjustment knob. This knob provides for a rate of feed from a minimum of 6.5 inches per hour to a maximum of 12 inches per hour.

Q. Can the positive carbon be fed forward manually? *A.* Yes, by pushing in and turning the manual drive crank clockwise, at the same time pushing in the manual positive feed button.

Q. What should be done if the thermostat fails? *A.* By observing the positive arc crater on the arc image screens, the crater can be moved to the focal point by simply pushing in the manual positive feed button and holding it until the positive crater returns to the focal point.

Q. How is the negative carbon kept at its proper position? *A.* By means of the current regulator, which is electrically connected to the feed coil and retract coil.

Q. How does the current regulator operate? *A.* The current regulator operates on a current principle. When the arc length is normal the current through the regulator is 150 amperes. This condition will cause the movable contact to be centered and neither the feed coil nor retract coil will be energized. When the current increases or decreases from the normal value of 150 amperes, as a result of a change in the arc length, the movable contact on the regulator will move to close either the feed coil circuit or the retract coil circuit. This in turn will cause the carbon to resume its normal position.

Q. Can the negative carbon be fed or retracted manually? *A.* Yes, by pushing in the manual negative drive and turning the crank in the desired direction.

Q. How is the lamp kept cool? *A.* There is a small motor-driven fan located on top of the searchlight which draws air from openings in the drum and through the lamp support column.

Q. How can the arc be struck? *A.* Either automatically or manually.

(1) *Automatically.*—Close the main switch. The current regulator will cause the negative carbon to feed forward rapidly until the negative carbon touches the positive carbon. The rush of current

will cause the retract coil to operate and retract the carbon quickly to its normal position where it will draw 150 amperes.

(2) *Manually.*—Push in the manual negative drive and turn the crank clockwise to feed the negative carbon forward until it strikes the positive carbon. Then quickly turn the crank counterclockwise and retract the carbon until the normal current of 150 amperes is indicated on the ammeter. When the manual negative drive crank is pushed in, an electric interlock opens the circuits of the magnetic clutch coils, thus preventing the automatic negative drive mechanism from functioning.

Q. When using the distant electric control, what actually positions or trains the searchlight? *A.* Two small direct current motors, one for training in azimuth and the other for training in elevation.

Q. How is the lamp recarboned? *A.*

(1) *Positive carbon.*—(*a*) Release the feed rollers by means of the feed roller clamp lever.

(*b*) Insert the new carbon through the hole in the positive head.

(*c*) Set the tip of the carbon so that it extends ¾ to ⅞ of an inch beyond the obturator nose.

(*d*) Secure the feed roller clamp lever so that the positive rollers grip the carbon.

(2) *Negative carbon.*—(*a*) Push the release lever (negative carbon drive roller handle) in the direction of the positive head.

(*b*) Insert the negative carbon and push it forward until the point is about ¼ inch from the positive carbon tip.

(*c*) Secure the feed roller levers.

Q. With respect to the positive carbon, when the arc is burning what should the operator especially observe? *A.* He should be particularly careful that the tip of the positive carbon does not burn beyond the line marked "Danger," otherwise serious damage may result from burning of the obturator on the positive head. Furthermore, the operator must observe the beam in order to judge the satisfactory operation of the arc.

b. Care.—*Q.* Name the parts which should be cleaned daily. *A.*

(1) *Positive and negative contacts.*—Use the cleaning stone on the alinement gage.

(2) *Thermostat mirror.*—Use a clean, dry cloth or chamois skin.

(3) *Obturator.*—Remove all dust, and ream if necessary with the reamer included in the tool kit.

Q. How is the thermostat cleaned? *A.* Remove the thermostat and inspect the contacts for pitting or burning. If necessary, clean the surface of the contacts by passing a fine, clean file between the contacts. Replace the thermostat.

Q. How should the collector rings be serviced? *A*. The collector rings are accessible through a handhole in the searchlight turntable. The collector rings should be cleaned with a clean cloth soaked in alcohol. If the rings are discolored they may be polished by using a clean chamois skin. If the rings are pitted or burned, use a clean, thin file for smoothing the surface. Great care must be taken not to remove the thin silver coating on these rings.

Q. In lubricating, what should you watch for? *A*. Be careful not to overlubricate. All excess lubricant should be carefully wiped off. Make sure that oil or grease does not get on the motor brushes, brushholders, commutators, coils, or slip rings.

Q. How should the lamp bearings and lamp head gears be lubricated? *A*. All lamp bearings and lamp head gears subject to high temperatures should be lubricated with Aquadag, a material consisting of graphite in suspension in water. If Aquadag is not available use flake graphite diluted in kerosene. When Aquadag is used it should be sprayed on; if a spray is not available apply sparingly with a brush.

Q. What other parts require lubrication? *A*.

(1) The worm and gear of the lamp motor positive drive should be lubricated frequently but not excessively.

(2) The bearings of the lamp control mechanism should be lubricated with a few drops of light machine oil.

(3) The bearings of the dynamotor are filled with grease at the factory; they should be lubricated from time to time through tapped holes in the bearings.

Q. Where can information on adjustments and trouble shooting be found? *A*. In the Operator's Manual furnished with each searchlight.

80. Control stations, general.—*Q*. How can the searchlight be controlled or trained? *A*. Two means are provided:

(1) The extended hand controller.

(2) The distant electric control.

Q. What does the control station accomplish? *A*.

(1) Provides remote control of the searchlight.

(2) Synchronizes the searchlight with sound locator data.

(3) Positions the binocular and open sight assembly. (Note that the M-VI does not have a binocular mount.)

81. Sperry control stations.—*a*. *General*.—*Q*. Should the azimuth gear and pinion be lubricated? *A*. No. They should be cleaned once a month with gasoline, and never lubricated, as lubricating will cause dust and dirt to gather on the gear teeth.

Q. How should the electrical contact rings and brushes be cleaned? *A*.

(1) Clean with alcohol when needed. Use No. 00 sandpaper if necessary to clean burned spots.

(2) The slip rings and brush assemblies in the tripod should be cleaned every 6 months.

(3) The D. E. C. transmitter rings and segments should be cleaned every 3 months.

(4) All electrical contacts should be clean and bright. Wipe off all contacts after using an abrasive. Do not permit oil or grease on the insulation.

Q. How should the control station be lubricated? *A*. Due to the fact that most of the control unit mechanism bearings are grease-sealed at the factory, little attention to lubrication is required. However, when the control unit cover is removed for cleaning, the gear teeth and bearings should be inspected and a few drops of machine oil applied as necessary.

b. *Sperry M1937, M1939, M1940, and M1941*.—*Q*. Of what does the control station consist? *A*. It consists of a tripod, control unit, and binocular mount.

Q. How is the searchlight synchronized with the sound locator data? *A*. Self-synchronous transmitters on the sound locator transmit, electrically, the angular movements of the sound locator self-synchronous receivers which are mounted and geared to the searchlight. The electrical output of the receivers goes to a phase detecting circuit, thence to d-c, double throw, zero reading voltmeters. When the indicator on the zero reading voltmeter is at the zero position, the searchlight is pointed or synchronized with the sound locator data. There are a total of four zero reading voltmeters, two for azimuth and two for elevation. One set (one azimuth and one elevation) of zero readers is mounted on the searchlight drum, and the other set is mounted on the control station.

Q. How many men are required to operate the control station? *A*. Three: an azimuth zero reader operator, an elevation zero reader operator, and an observer.

Q. What are the duties of each man? *A*.

(1) The zero reader operators turn their respective handwheels to keep the zero pointers on the center, or zero, position of the azimuth and elevation zero-reader indicators. If the target is not "flicked" when the searchlight goes into action, the zero reader operators cause the searchlight (except in the M1937 control station) to search in the vicinity of the sound locator data by operating their

handwheels so as to cause the pointers of the zero reader meters to move slowly, alternately to the right and left of the zero position. In the M1937 control station an automatic means is provided for searching; pushing down the search control knob operates an automatic search in elevation; turning the search control knob offsets the potentiometer which controls the pointer of the azimuth zero reader; thus the observer controls an automatic search in elevation, and a search in azimuth by offsetting the pointer of the azimuth zero reader.

(2) When the target is flicked the zero reader operators relinquish control of their respective handwheels and the observer then takes over the control and follows the target by means of the observer's handwheels.

Q. What is actuated when the azimuth zero reader's handwheel, or observer's azimuth handwheel, is turned? *A.* The control unit is turned in azimuth and the azimuth distant electric control transmitter is driven in azimuth. This causes the searchlight also to be moved in azimuth.

Q. What is actuated when the elevation zero reader's handwheel, or observer's elevation handwheel, is turned? *A.* The binocular mount is moved in elevation and the elevation distant electric control transmitter is driven in elevation. This causes the searchlight to be elevated or depressed.

Q. Is there a means of signaling at the control station? *A.* Yes. There is a push button on the control station that operates a buzzer on the searchlight. On the M1941 control station there is a buzzer which is operated by a push button at the sound locator.

Q. What is the color of the control cable plugs and receptacles? *A.* Red.

Q. What is the minimum distance that the control station should be placed from the searchlight? *A.* 50 feet.

Q. What type of distant electric control is used on Sperry searchlights, with the exception of the M–VI. *A.* A d-c step-by-step system, which operates on the same voltage as does the arc.

c. Sperry M1934.—*Q.* Of what does the control station consist? *A.* It consists of a tripod and control unit, including binoculars.

Q. How is the searchlight made to follow the sound locator data? *A.* Self-synchronous transmitters on the sound locator transmit, electrically, the angular movements of the sound locator to self-synchronous receivers, which are mounted in the control station and position an inner dial of a set of concentric dials. The outer dials are geared to the control unit, and indicate the azimuth and elevation of the

control unit and searchlight, when correctly oriented and synchronized.

Q. How is searching accomplished? *A*. The searching is accomplished by a searching handwheel which superimposes an additional motion to the elevation and azimuth transmitters.

Q. How many men are required to operate the control station? *A*. Three: observer, azimuth follow-the-pointer operator, and elevation follow-the-pointer operator.

Q. What are the duties of each man? *A*. The follow-the-pointer men at the control station operate their handwheels so as to keep the searchlight dials continuously matched with the sound locator dials. If the target is not flicked, the observer should start searching by turning the searching handwheel continuously in a clockwise or counterclockwise direction. When the target is flicked, the follow-the-pointer men should relinquish control of their respective handwheels to the observer, who from then on follows the target by means of the observer's handwheels.

Q. What type of distant electric control is used on the M1934 Sperry searchlight? *A*. A d-c step-by-step system, which operates on the same voltage as does the arc.

d. Sperry M–VI.—*Q*. Of what does the control station consist? *A*. It consists of a tripod, controller, and comparator.

Q. How is the searchlight made to follow the sound locator data? *A*. Self-synchronous transmitters on the sound locator transmit, electrically, the angular movements of the sound locator to self-synchronous receivers, which are mounted in the comparator and position an outer dial of a set of concentric dials. The inner dial is positioned by a self-synchronous receiver which is electrically connected to a self-synchronous transmitter on the searchlight. Operating the controller handwheels causes the searchlight to be trained in elevation and azimuth and when the pointers on these two concentric dials at the comparator are matched, the searchlight is pointing in the proper direction if the searchlight unit has been correctly oriented and synchronized.

Q. How many men are required to operate the control station? *A*. Three: observer, azimuth, follow-the-pointer operator, and elevation follow-the-pointer operator.

Q. What are the duties of each man? *A*. The follow-the-pointer men at the control station operate their handwheels so as to keep the searchlight dials continuously matched with the sound locator dials. If the target is not flicked, the follow-the-pointer men cause the searchlight to search around the sound locator data by manipulat-

ing their respective handwheels so as to cause the searchlight pointer to move slowly back and forth within 5° of the sound locator pointer.

Q. What type of D. E. C. is used by the M-VI searchlight? *A*. A brush shifting type. The handwheel at the comparator positions a d-c step-by-step transmitter which in turn positions a d-c step motor at the searchlight causing the brushes of the training motor to be shifted, imparting a torque to the training motor.

82. General Electric control station M1940.—*a. Operation.*—*Q*. Of what does the control station consist? *A*. It consists of a tripod, control unit, and binocular mount.

Q. What type of D. E. C. is used by the General Electric searchlight M1940? *A*. A self-synchronous control system which controls the operation of the d-c training motors.

Q. How are data transmitted from the sound locator? *A*. From self-synchronous transmitters on the sound locator to receivers on the searchlight, then to zero reading voltmeters on the searchlight and control station.

Q. How are the movements of the control station transmitted to train the searchlight? *A*. The rotation of the handwheels at the control station positions a self-synchronous transmitter, which, in turn, causes a rotor on the searchlight self-synchronous receiver to follow the rotation of the transmitter rotor. The rotor on the searchlight receiver positions a heart-shaped cam which controls a contact operating plate in a resistance bridge. Movement of the contact operating plate changes the bridge resistance in such a way as to control the operation of a d-c driving motor on the searchlight. When the searchlight has been rotated the required amount, the heart-shaped cam is set back to its neutral position in the following manner: A system of gears from the searchlight turns the stator housing of the self-synchronous receiver in the opposite direction to that of the receiver rotor. This movement is reflected in a corresponding rotor movement which returns the heart-shaped cam and contact operating plate to the neutral position.

Q. How many revolutions of the distant electric control transmitters and receivers correspond to one revolution of the searchlight? *A*. The transmitters and receivers make 36 revolutions for each revolution of the searchlight. Therefore, the control station and the searchlight will be auto-synchronous only in a 10° arc.

Q. How many men are required to operate the control station? *A*. Three: an azimuth zero reader operator, an elevation zero reader operator, and an observer.

Q. What are the duties of each man? *A*. The zero reader oper-

ators turn their respective handwheels to keep the zero pointers on the center or zero position of the azimuth and elevation zero reader indicators. If the target is not flicked when the searchlight goes into action, the zero reader operators cause the searchlight to search in the vicinity of the sound locator data by operating their handwheels so as to cause the pointers of the zero reader meters to move slowly alternately to the right and left of the zero position. When the target is flicked, the zero reader operators relinquish control of their respective handwheels, and the observer then takes over the control and follows the target by means of the observer's handwheels.

Q. What is actuated when the azimuth zero reader's handwheel or observer's azimuth handwheel is turned? *A*. The control unit is turned in azimuth and the azimuth distant electric control transmitter is driven in azimuth. This causes the searchlight also to be moved in azimuth.

Q. What is actuated when the elevation zero reader's handwheel or observer's elevation handwheel is turned? *A*. The binocular mount is moved in elevation and the elevation distant electric control transmitter is driven in elevation. This causes the searchlight to be elevated or depressed.

Q. Is there a means of signaling at the control station? *A*. Yes. There is a push button on the control station which operates a buzzer on the searchlight. On the M1941 control station there is a buzzer which is operated by a push button at the sound locator.

Q. What is the color of the control cable plugs and receptacles? *A*. Red.

Q. What is the minimum distance that the control station should be placed from the searchlight? *A*. 50 feet.

b. *Care*.—*Q*. How should the control station be cleaned? *A*. (1) The azimuth ring gear and pinion should be cleaned monthly by means of a brush dipped in gasoline. Do not lubricate this gear of pinion, since it would tend to accumulate dirt and dust.

(2) The brushholder and rings should be cleaned with alcohol every 6 months. They should be kept clean by wiping from time to time.

(3) All electrical contacts should be clean and polished. Never allow oil or grease to accumulate on the insulation.

Q. How should the control station be lubricated? *A*. Most of the bearings are sealed in oil at the factory. However, when the cover is removed for cleaning, inspect the teeth of the gears and bearings and, if necessary, apply a small quantity of grease to the gears and a few drops of light machine oil to the bearings.

SECTION X

CARE AND OPERATION OF SOUND-LOCATOR APPARATUS

83. General.—*Q.* What faculty of an individual enables him to determine the direction from which a sound is coming? *A.* Binaural sense. It is a faculty of the auditory system.

Q. Are the horns pointed at the "true source" of the sound? *A.* No. The horns are pointed at a point in rear of the true source, known as the "apparent source" of the sound, due to the fact that sound travels in air at a speed of only 1,100 feet per second, and consequently takes an appreciable time to arrive at the sound locator. During this sound lag time, the airplane is traveling. The direction to the apparent source of sound is corrected by the sound lag corrections (plus wind and parallax) in order to point the searchlight at the true source of sound.

84. M1 series sound locations.—*a. Operations.*—*Q.* How are the horns of an M1 series locator put in their operating position? *A.* Remove the horns from the traveling position supports by releasing the horn locking frame pins. Then clamp the horns into place on the horn support by means of the double hooks and hand clamp screws. Be sure the numbers on the horns and supports correspond.

Q. How is the locator chassis leveled? *A.*

(1) Unlock the turntable by loosening the three locking screws.

(2) Lower the four leveling jacks, then by means of these jacks raise the trailer chassis until the four wheels are free to turn.

(3) Move the turntable so the level bubbles point over diagonal wheels. Adjust the jacks until the two level bubbles located on the turntable show that the sound locator is level. After leveling, check by turning the locator through 180°.

For illustration of sound locator M1A1 see figure 99.

Q. How is the sound locator oriented in azimuth? *A.* With the aid of the open sights on the lower elevation horn, orient the sound locators with respect to the searchlight. Then set the azimuth on the acoustic corrector with all correction scales set to zero, to zero degrees (on M1A1 to M1A4, incl.), or to zero mils (on M1A5 to M1A8, incl.).

Q. How is the sound locator oriented in elevation? *A.* Set the sound locator horns to zero elevation. Then set the acoustic corrector to zero degrees (or zero mils).

Q. How is the sound locator operated? *A*. Each listener seats himself at his control handwheel and adjusts his helmet. He then traverses (or elevates or depresses) the horns until they point in the general direction from which the sound is expected (from information given by outpost listeners), or a systematic search is made for possible attacks by enemy airplanes. As soon as a sound is picked up, both operators "center" on the sound so that it appears to come from directly in front or directly in rear of the listener's head (the direction is sensed as front or rear by different listeners), and when this is done the sound locator will be pointed at the apparent source of sound.

Q. How is the M1 or M1A1 acoustic corrector operated? *A*. The chief of section announces the altitude in feet, which is set in by the elevation acoustic corrector operator. As the listeners track the target, the azimuth acoustic corrector operator reads the time on the sound lag cylinder which is graduated in seconds; if it is 4.2 seconds, he calls "Four-point-two," at which time both corrector operators push their prediction knobs "in." At the end of 4.2 seconds (measured by a stopwatch), the chief of section gives the command TAKE, at which time the corrector operators release their prediction knobs. The angles indicated on the prediction scales by the prediction pointers are the sound lag angles and are matched by causing the follow up pointers to agree with the prediction operating pointers. This corrects the apparent source data to the true source and is sent by the data transmitters to the searchlight. (Arbitrary corrections must be set in on the arbitrary correction scales to correct for wind and parallax.) For illustration of acoustic corrector M1 see figure 100.

Q. How is the M2 acoustic corrector operated? *A*. The chief of section directs the duties of the corrector operator. This acoustic corrector uses a motor (a switch on the acoustic corrector must be turned to the "on" position) which operates automatically the mechanisms which measure azimuth and vertical angular travel during the sound lag time. Altitude in feet is set in by the operator on the altitude scale. As the sound locator tracks the target, the operator alternately matches the pointers of the lateral and vertical rate dials by rotating the corresponding handwheels. The matching of pointers must be done within the 4-second period when the inner pointers are at rest. For illustration of acoustic corrector M2 see figure 101.

b. *Care*.—*Q*. If the locator is to be left assembled after use, should the horns be elevated or depressed? *A*. The horns should be depressed as far as possible in order to prevent rain from entering them.

Q. How often should the horn mount be lubricated? *A*. Each day

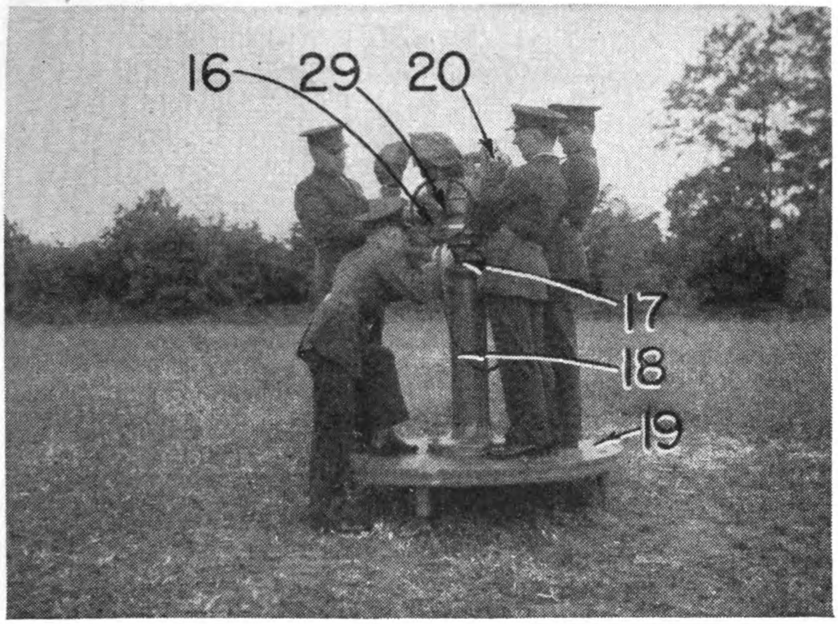
before operating the locator. Alemite fittings are provided. Use medium lubricating oil (SAE No. 30) for summer operation and light lubricating oil (SAE No. 20) for winter operation. An oil gun is provided for this purpose. These alemite fittings are located as follows:

Azimuth handwheel shaft and gear housing	4
Elevation handwheel shaft and gear housing	4
Traversing worm housing	6
Elevation shaft housing (horizontal)	9
Elevation worm segment housing	5
Horn journal (left)	1
Horn journal (right)	2
Turntable	1
Gear housings (below platform)	7

Q. How often should the trailer be lubricated? *A.* Every 500 miles. Alemite fittings are provided. Use medium lubricating grease (SAE No. 160) for summer operation and light lubricating grease (SAE No. 90) for winter operation. A grease gun is provided for this purpose.

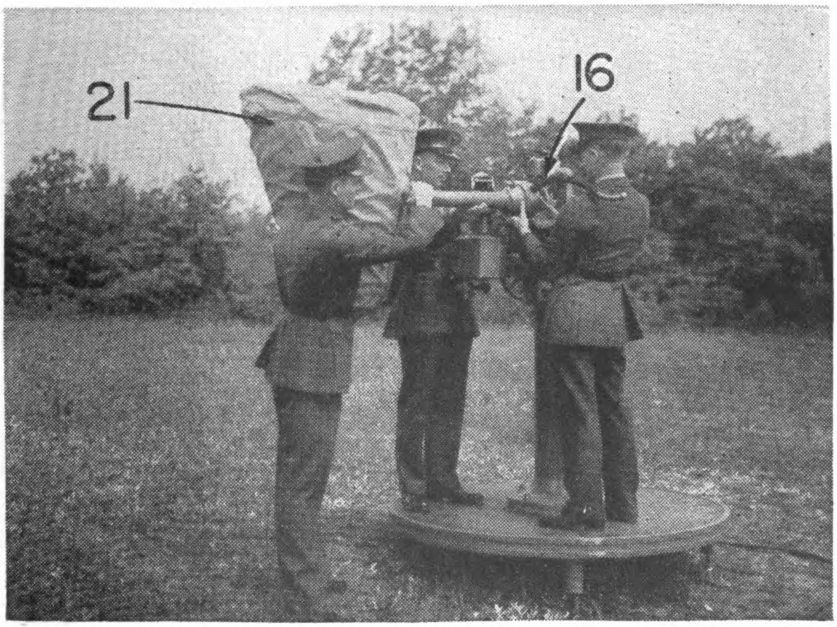
Q. How often should the acoustic corrector be lubricated? *A.* The acoustic correctors require no maintenance in the field. Every 6 months the covering plates should be removed and the corrector lubricated. On the cam of the M2 corrector, use petrolatum (U. S. Army Spec. No. 2-67). For the gearing and shafting use grade 2 clock oil (U. S. Army Spec. No. 2-47A).

85. M2 sound locator.—*a. Operation.*—*Q.* Describe the assembling of the M2 sound locator for field operation. *A.* Place the platform at the position indicated by the chief of section, and adjust until the platform is approximately level. Place the column on the platform and bolt it in place. Place the corrector assembly on the column, first dropping the cable receptacle through the inside of the column. Bolt the corrector assembly to the column and fasten the cable receptacle to its bracket under the platform. Remove the transportation bracket. Elevate the elevation mechanism to 90° and clamp tightly by means of the elevation clamp. Bolt the single-horn assembly in place, then the two-horn assembly. The horns are handled more easily if the canvas covers are removed after horns are assembled. Mount the pantograph on the corrector, screwing it on by means of the pantograph screw knob. Level the sound locator exactly, using the wrench provided to adjust the jacks. Check the level bubble through 180° traverse of the sound locator to insure correct leveling. Connect the blue cable plug to the blue receptacle.



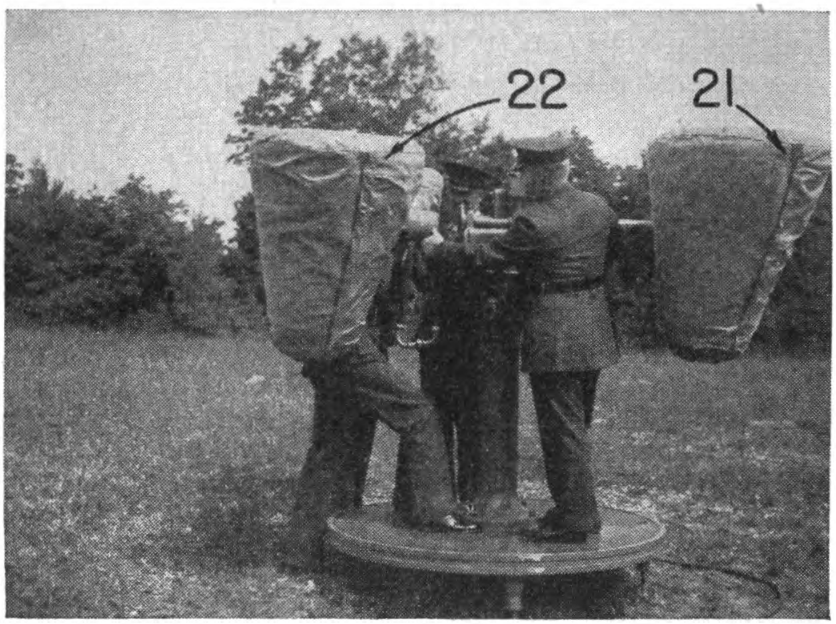
16. Corrector assembly.
17. Cable plug (female).
18. Column.
19. Platform.
20. Transportation bracket.
29. Azimuth handwheel clamp knob.

FIGURE 122.—Placing corrector assembly on column.



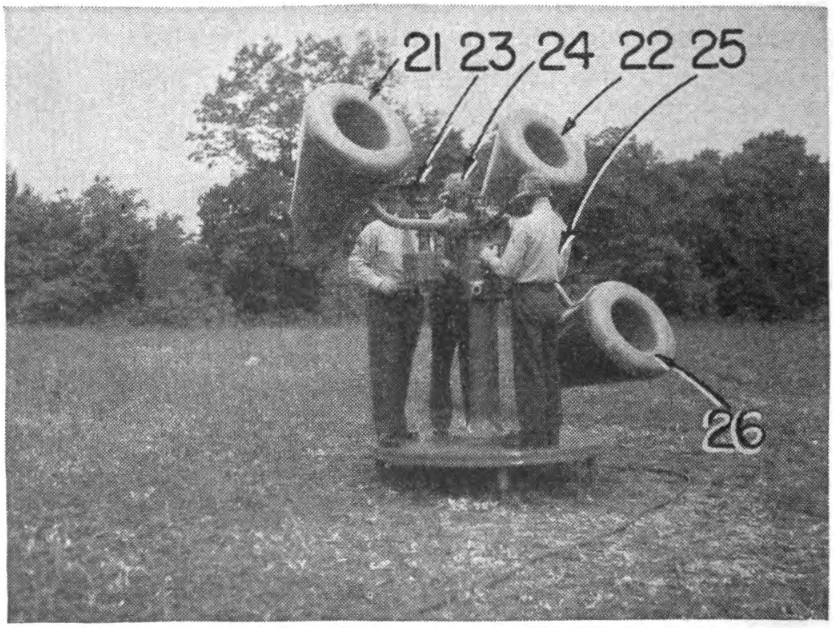
16. Corrector assembly.
21. Azimuth horn.

FIGURE 123.—Attaching azimuth horn to corrector assembly.



21. Azimuth horn. 22. Common (azimuth-elevation) horn.

FIGURE 124.—Attaching elevation and common horn unit to corrector assembly.



21. Azimuth horn.
22. Common (azimuth-elevation) horn.
23. Corrector operator.
24. Elevation listener.
25. Azimuth listener.
26. Elevation horn.

FIGURE 125.—Sound locator M2 in operating position.

Q. How is the M2 sound locator oriented? *A*.

(1) *Azimuth*.—(*a*) Set target speed to zero.

(*b*) Set parallax offset scale to zero.

(*c*) Loosen the azimuth clamp knob and point the sound locator at the orienting point (searchlight or distant point), using the corrector sight and getting the image of the pantograph pointer and the orienting point to coincide on the cross lines of the mirror. Be careful not to disturb the corrector handle until completion of orienting and synchronizing in azimuth.

(*d*) Tighten the azimuth clamp to hold sound locator in position.

(*e*) Set the sound locator scale to zero by loosening the scale and turning it until zero on the scale is under the index pointer.

(*f*) Push down on the declutching gear and rotate the parallax cam so that the arrow points at the searchlight. Then remesh gearing.

(2) *Elevation*.—(*a*) Lock the sound locator at zero elevation by means of the clamp lock.

(*b*) With zero speed and parallax settings, center the pantograph pointer on the cross lines of the mirror. Be careful not to move the corrector handle thereafter until completion of orienting and synchronizing in elevation.

Caution: Even when the sound locator and the searchlight are at different levels, the foregoing elevation adjustment is not to be disturbed. This results in sighting on a vertical line through the orienting point instead of directly on the orienting point.

Q. How is the M2 sound locator operated? *A*. Set in the target's air speed and the parallax offset. This information is given by the chief of section. The corrector operator then keeps the pantograph pointer centered on the cross lines of the mirror, using the corrector handle to accomplish this. The listeners track the sound and should do this as smoothly and steadily as possible. Any sudden movement of the horns causes the pantograph pointer to move erratically. The corrector operator must avoid any sudden change when he is centering the pantograph pointer because it will affect the data sent to the control station.

b. *Care*.—*Q*. Who are authorized to make parts replacement on the M2 sound locator? *A*. Only qualified ordnance personnel are authorized to make parts replacement on the M2 sound locator.

Q. How often should the metal mirror be cleaned? *A*. Not any oftener than is necessary. If the mirror becomes greasy it may be cleaned with soft cotton moistened with alcohol. If the mirror becomes exceptionally dirty or greasy, the surface may be cleaned with

a mixture of 3 ounces of precipitated chalk and 8 ounces of a good grade of denatured alcohol.

Q. How often should the slip rings be inspected? *A.* Monthly. If dirty, clean with a soft cloth moistened with carbon tetrachloride. Use only a clean cloth.

Q. How is the rubber guard on the open sight cleaned? *A.* Remove it and wash in warm water, then dust it with French chalk to preserve it.

Q. Should water be allowed to get in the horns? *A.* No. Water, dirt, or other foreign matter should be kept out of the horns.

Q. What parts of the sound locator should be lubricated? *A.* The three red plugs on the sight assembly should be lubricated, using a light instrument oil. In addition the chain drives inside the locator should be greased with Andok C grease, or, if this is not available, use a good grade of vaseline. To get at the chains remove the cover plate on the corrector.

SECTION XI

CARE AND OPERATION OF SEACOAST SEARCHLIGHT

86. Fixed seacoast searchlight.—*Q.* Name the essential parts of a fixed harbor defense searchlight. *A.* Projector, lamp mechanism, distant electric controller, power supply unit.

Q. How is the searchlight moved while following a target? *A.* Either by hand control or by distant electric control. The distant electric control training mechanism is located in the base of the searchlight.

Q. What is the purpose of the ventilating system? *A.* When the lamp is in operation, the heat given off by the incandescent carbons is tremendous and if it were not carried away would soon damage the lamp mechanism. To carry away the hot air, soot, and gases from the lamp mechanism, window, and mirror, a motor-operated blower is located in the ventilating hood on the top of the drum. This blower operates whenever the lamp is in use.

Q. Where is the contactor panel and what does it contain? *A.* The contactor panel is mounted in a metal box on the left trunnion arm. It contains the electrical reading instruments and control switches for supplying voltage and current to the lamp.

Q. Where is the control box and what does it contain? *A.* The control box, in the lamp trough, contains all the mechanism for rotat-

ing and feeding the carbons and for cooling the electrode holders. A small feed motor provides all the power for operating the various mechanisms. A fan mounted on one end of the motor shaft drives a current of air through the hollow air tube columns supporting the electrodes and in this way cools the electrodes.

Q. What is contained in the instrument box? *A*.

(1) Thermostat.

(2) Ground glass finder.

(3) Arc length rheostat.

Q. What is the purpose of the thermostat? *A*. It controls the automatic movement of the positive carbon so as to maintain the positive crater in the proper focal position.

Q. Describe the ground glass finder. *A*. The ground glass finder is a small compact lens system by which the image of the arc is plainly reproduced right side up and three-quarters size on the ground glass. The proper positions of the carbons when focused can be marked on the ground glass and thereafter used as a means of focusing the beam.

Q. What is the purpose of the arc length rheostat? *A*. The arc length rheostat makes it possible to change the length of the arc during the operation of the lamp. If it is desired to lengthen the arc, the rheostat pointer is moved to the left; and if to shorten the arc, it is moved to the right.

Q. How do you carbon the lamp? *A*.

(1) Turn the lower lamp control switch to "local control" position. Make sure that the upper lamp switch is "off."

(2) Turn the carboning lamp switch to "on."

(3) Insert the positive carbon through the carbon-protecting tube of the front door after moving aside the cover.

(4) Push out the old positive carbon stub with the new positive carbon and run the latter through the positive head until it projects ½ inch from the tip of the quartz bushing.

(5) Open the side door and turn the negative frame so as to spread the negative feed rollers.

(6) Open the cover of the hole in the stray light shield.

(7) Insert the negative carbon (square end first) through the hole, pushing out the negative stub and running the negative carbon through the negative head contacts until its end is about ½ inch from the end of the negative jaws.

(8) Close the hole in the stray light shield.

(9) Turn the negative frame back into position with a snap.

(10) Remove the carbon stubs from the barrel.

(11) Turn the carboning lamp switch "off."

(12) Turn lower lamp control switch to "remote control" position, if remote control is being used.

Wear gloves and use combination pliers when carboning lamp. If the arc end of either carbon is broken, reshape it before using this damaged carbon.

Q. How do you start the arc? *A*.

(1) Close all doors in the barrel and in the lamp compartment.

(2) Turn the lower control switch (on the side of the contactor box) to "local" unless it is desired to operate the light by distant electric control, in which case turn the switch to "remote."

(3) Open the instrument box and ground glass finder covers and move the handle of the arc length rheostat to the extreme "lengthen" position.

(4) Observe the voltmeter and if the voltage is over 105 volts turn the upper lamp control switch to "on." Hold at "on" until the arc is struck.

(5) Proceed at once to the instrument box and observe the ground glass finder.

(6) Adjust the arc length rheostat to give the normal arc length (¾ inch on the ground glass).

Q. How do you adjust the thermostat? *A*.

(1) Open the thermostat contacts by moving the clamping and adjusting levers to the *left*.

(2) Feed the positive carbon forward to the mark on the finder and have an assistant maintain it in this position by means of the push button.

(3) Look through the lens in the thermostat casing and move the lever slowly to the *right* until the space between the contacts is barely perceptible.

(4) Lock the lever in this position by moving the clamping arm against the stop.

(5) Release the push button and observe the action of the positive carbon. The contacts should close almost immediately after the positive carbon starts to burn back from the mark. The sound of the positive feed is quite audible.

(6) If the positive carbon starts to feed beyond the mark the distance between the contacts should be increased by moving the lever slightly to the left and reclamping.

(7) If the positive carbon starts to turn back of the mark the distance between the contacts should be decreased by moving the lever slightly to the right.

Q. What is the appearance of the arc when the lamp is in operation? *A*. Looking in the ground glass finder, the crater of the positive carbon is in line with the heavy focus line etched on the ground glass finder. The length of the arc (the distance between the tip of the negative carbon and the edge of the positive crater) is about ¾ inch. The length may vary under different conditions from ⅝ to 1⅛ inches.

Q. How are the carbons moved to take care of the burning away of the ends during operation? *A*. Either by hand or automatically.

Q. What do you do if either carbon fails to function automatically? *A*. Open the door at the rear of the lamp compartment.

(1) *Negative carbon.*—Push in the clutch crank and turn it to the right to feed forward, or to the left to feed backward.

(2) *Positive carbon.*—Push in the hand lever and pull down until it catches. Maintain the lever in this position until the desired feed is obtained.

Q. What do you do if the arc is too short? *A*. Move the handle of the rheostat to lengthen, or move the voltage regulator screw down.

Q. What is the appearance of the beam when the lamp is being operated correctly? *A*. When viewed from a position a few feet from the side of the lamp the beam should appear steady and bright and of a clear white color. There should be no flickering. The upper and lower edges of the beam should appear to be nearly parallel to each other; that is, the beam should not appear fan-shaped, nor should the edges of the beam appear to come together a long distance away. Adjusting the beam until it appears as described above is called "focusing the light."

Q. How do you adjust the beam when it appears "bluish" and when it flickers? *A*.

(1) When the beam appears of a bluish color the current has dropped below 150 amperes. Readjust current.

(2) When the beam flickers the current has risen above 150 amperes. Readjust current.

Q. How do you focus the light? *A*.

(1) When the beam is fan-shaped, open thermostat contacts and turn the focusing screw so as to move the lamp mechanism away from the mirror. Readjust the thermostat and thermostat mirror so as to maintain the new focus with the positive crater at the proper distance from the positive head.

(2) When the edges of the beam cross, open the thermostat contacts and turn the focusing screw so as to move the lamp mechanism toward mirror. Readjust thermostat as indicated above.

Q. How do you put the lamp out of action? *A*. If light is being operated from control station, controller operator opens lamp control switch on controller. If "local" control is being used move the upper lamp switch to "off."

Q. Where can detailed information be found on the care and operation of fixed seacoast searchlights? *A*. "Instruction Book No. 12, Description, Operation, and Care of 60-inch, Barrel Type, Searchlight Equipment, Engineer Department, U. S. Army, 1921."

Q. Describe the care of the searchlight. *A*.

(1) *Mirror*.—In cleaning the mirror, remove the dust with a large dust brush and then polish with a chamois skin. If the mirror becomes dirty or greasy, clean with a solution of one-fifth part precipitated chalk, four-fifths part water, (both by volume), and 2 tablespoonfuls of alcohol per quart of solution. Apply this solution carefully with a sponge and polish with a soft cloth.

(2) *Carbons*.—Carbons must be handled carefully and kept dry. They should be kept covered in the tin cans in which they are shipped. Do not use any negative carbon which has its copper coating torn.

(3) *Gears in positive and negative head*.—Lubricate all gears and bearings in the positive and negative heads. They should be lubricated with a mixture of graphite and vaseline or with the graphite compound furnished. In continuous runs, the gears in the heads should be lubricated while recarboning.

(4) *Control box*.—Vaseline should be used in lubricating the gear box. If excessive lubricant is used, it will work back through the bearings of the motor to the commutator. Graphite should *not* be used in the gear box, since it may short circuit the commutator. Light machine oil should be used sparingly for oiling all other bearings of the lamp mechanism.

(5) *Contact finger*.—The part of the upper finger which makes contact with the negative carbon is lined with silver to prevent oxidation. Care must be exercised that the contact surface is kept clean and smooth and that an even, steady pressure is exerted on the carbon. The lamp should never be operated with excessive current. If operation at over 200 amperes is continued for any length of time, the silver lining of the upper negative contact finger may melt.

(6) *Negative head compression spring*.—The negative contact jaws are held against the carbon by a compression spring acting through a lever. The heat from the arc gradually weakens this spring. If the coil-type spring is furnished it must be replaced after about 10 hours of continuous burning. The hairpin-type spring will last much longer.

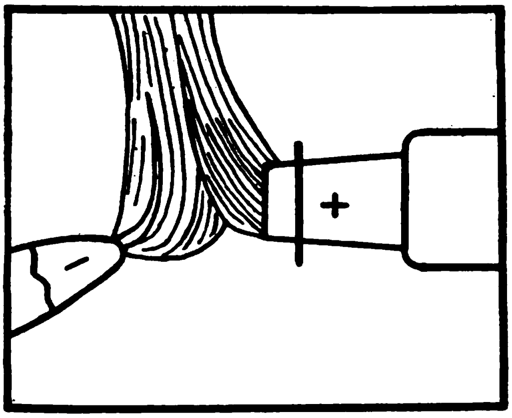


FIGURE 126.—Wrong—positive beyond mark.

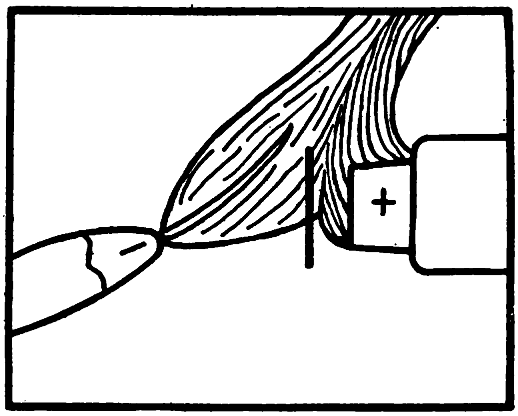


FIGURE 127.—Wrong—positive behind mark.

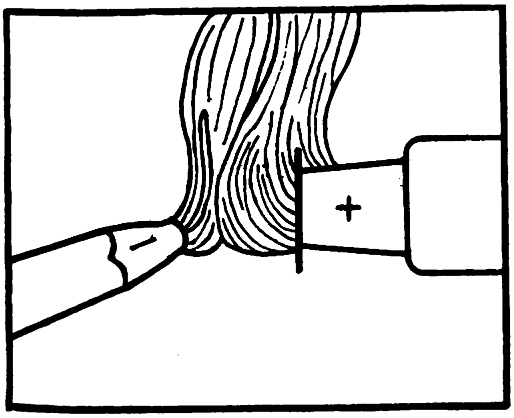


FIGURE 128.—Wrong—arc too short.

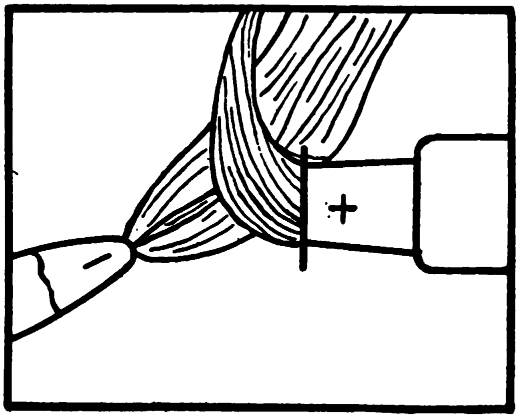


FIGURE 129.—Wrong—carbons out of line.

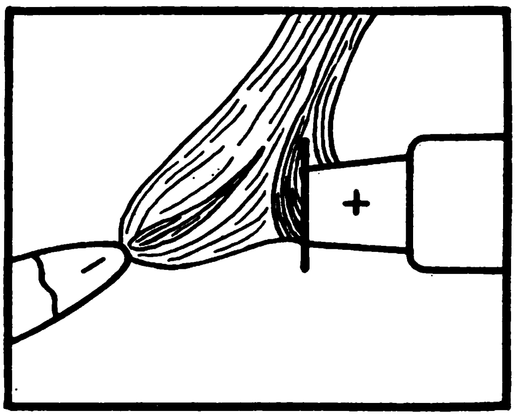
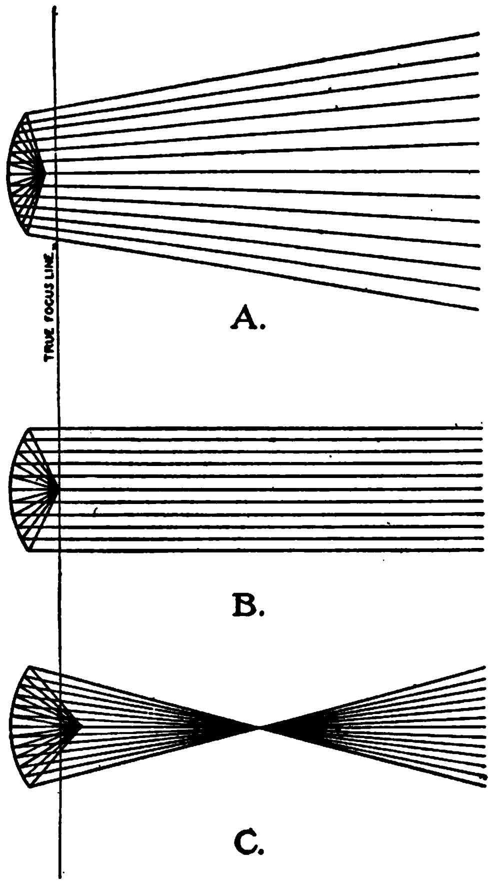


FIGURE 130.—Right.



A. Spread. B. Normal. C. Contracted.
FIGURE 131.—Beam condition.

87. Mobile seacoast searchlight.—The care and operation of this type of light is identical with that of the antiaircraft searchlight. (See appropriate paragraph as to type of light in sec. IX.)

SECTION XII

CARE AND OPERATION OF SEACOAST SEARCHLIGHT CONTROL SYSTEM

88. Fixed seacoast searchlight control system.—*Q*. What type of control system is standard for fixed seacoast searchlights? *A*. Synchronous-relay type.

Q. To what distance is the control system limited? *A*. To about 2 miles; that is, the controller will work efficiently when placed not more than this distance from the searchlight.

Q. What is the minimum voltage required for efficient operation of the controller system? *A*. 90 volts when both the arc and the con-

troller are in operation. This voltage is measured across the terminals of the connection box and is the limiting factor in the distance of the controller from the searchlight.

Q. How is the azimuth dial on the controller set to indicate the azimuth at which the searchlight is trained? *A*.

(1) Train the searchlight in azimuth by means of the slow speed electrical control to any division on the azimuth scale of the searchlight.

(2) Open the small door on the left side of the controller box; reaching in, slip the azimuth dial by hand until its index reads the same as the reading at the searchlight.

(3) The azimuth dial should stay in synchronism with the searchlight within 0.5°. If it does not, look for low voltage or slipping controller clutch.

Q. How is the speed of traverse of the searchlight varied? *A*. The change in speed of traverse of the searchlight is made by means of the speed control switch on the right side of the controller box.

Q. Can the speed of traverse be changed while the light is being traversed? *A*. No. The switch must be operated while the searchlight is at rest. Otherwise it might throw the azimuth dial out of synchronism with the light.

Q. How is the arc started from the control station? *A*.

(1) At the searchlight, turn the *lower* lamp control switch on the side of the contactor panel box to "remote."

(2) At the controller, turn the lamp control switch to "on."

NOTE.—The *upper* lamp control switch on the contactor panel box at the searchlight must be *open* when this change is made.

Q. How is the change to hand control made? *A*.

(1) Open the training circuit switch on the base of the searchlight.

(2) Change the *lower* lamp control switch on the contactor panel box to "local."

(3) Start lamp mechanism and ventilating motor by turning the *upper* lamp control switch on the contactor panel box to "on."

(4) Train the searchlight by means of the azimuth and elevation handwheels.

Q. How should the target be carried in the beam of the searchlight? *A*. The target should be carried in the side of the beam nearest the control station or side which is nearest the using organization. The lower edge of the beam should be placed at or below the water line of the target.

Q. Before attempting to train the searchlight by "remote" control when the system is first set up, what check should be made? *A*. The

light should be trained by hand to insure free operation. If it trains "heavy," have trouble cleared.

Q. How do you know that the elevation slip clutch is properly adjusted. *A*. When the stop on the elevation training rack is reached, the clutch should slip so easily that the elevation training motor will not stall but will be able to rotate the inner cone at reduced speed.

Q. What will happen to the elevation training motor if the clutch does not slip and the motor stalls? *A*. It will take excessive current and overheat.

Q. If the searchlight runs ahead of the azimuth controller index, what is probably wrong? *A*. The controller clutch is slipping. Have trouble cleared by the electrician sergeant.

Q. What care should be taken of all electric contacts? *A*. Inspect frequently; keep free from dirt and grease; keep free from burs or pits, smoothing with sandpaper or replacing when necessary; springs should be kept clean and under proper tension.

Q. What procedure of lubrication should be followed? *A*. Sparingly at frequent intervals rather than profusely and at infrequent intervals.

Q. Who is responsible for the proper adjustment and maintenance of the searchlight? *A*. The electrician sergeant assigned to the organization. The actual work may be done by the light crew under his supervision. Reports of trouble must be made promptly to him.

89. Mobile seacoast searchlight control system.—The control system for this type of light is identical with that of the antiaircraft searchlight. (See appropriate paragraph as to type in sec. XI.)

Chapter 9

MOTOR TRANSPORTATION

90. Nomenclature of major parts of motor vehicles.—*Q*. Into what general groups may the parts of any motor vehicle be divided? *A*. Power plant, transmission system, control system, chassis, running gear, and body.

Q. Point out the principal parts of the power plant to include the crankcase, cylinders, valves, and various parts pertaining to fuel, carburetion, ignition, lubrication, and cooling systems. *A*. ———.

Q. Point out the principal parts of the transmission system to include the clutch, transmission, driveshaft, universal joints, differential, torque arms, and axles. *A*. ———.

Q. Point out the principal parts of the control system, chassis, and running gear to include frame, springs, brake drums, brake rods, wheels, steering knuckle, drag link arm, emergency and foot brakes. *A*. ———.

Q. Why are instruments installed on the dash? *A*. For the purpose of indicating and controlling the operation of the engine and vehicle.

Q. What instruments are usually installed? *A*. Ammeter, oil pressure gage, speedometer, thermometer (engine temperature), choke, light switch, hand throttle, spark control, and ignition switch.

Q. What does the ammeter indicate? *A*. The amount of current that is being consumed by the ignition and light system of the vehicle from the battery, or the amount of current that the generator is supplying to the battery.

Q. What does the oil gage indicate? *A*. Oil pressure only. The quantity of oil is indicated by the dip stick. Lack of oil or oil pressure is very serious.

Q. Does the oil pressure gage indicate that the engine is being lubricated? *A*. No; it only indicates that the pump is forcing oil some place at the pressure indicated by the gage.

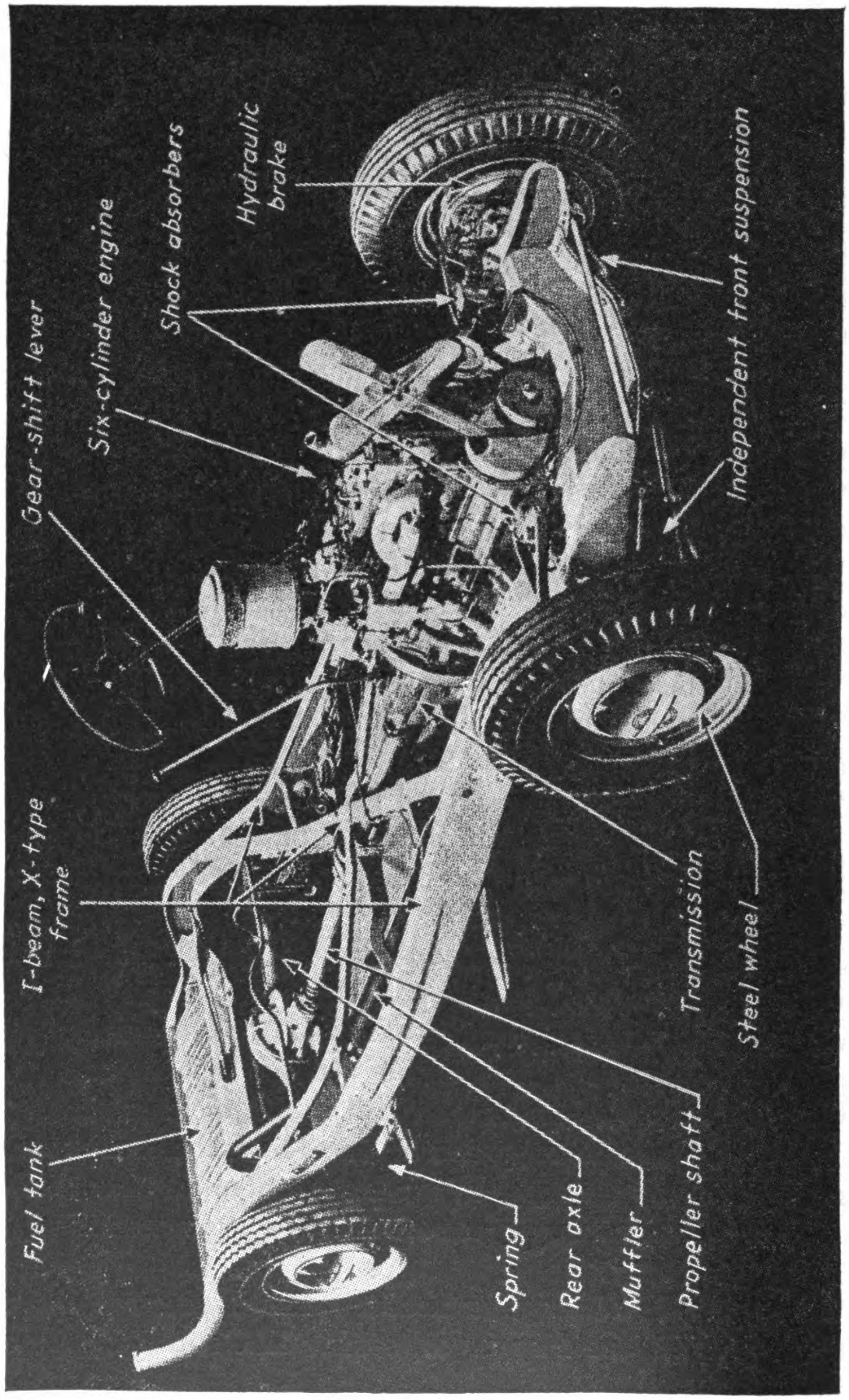


FIGURE 132.—Modern gasoline engine-driven passenger car chassis showing its various parts.

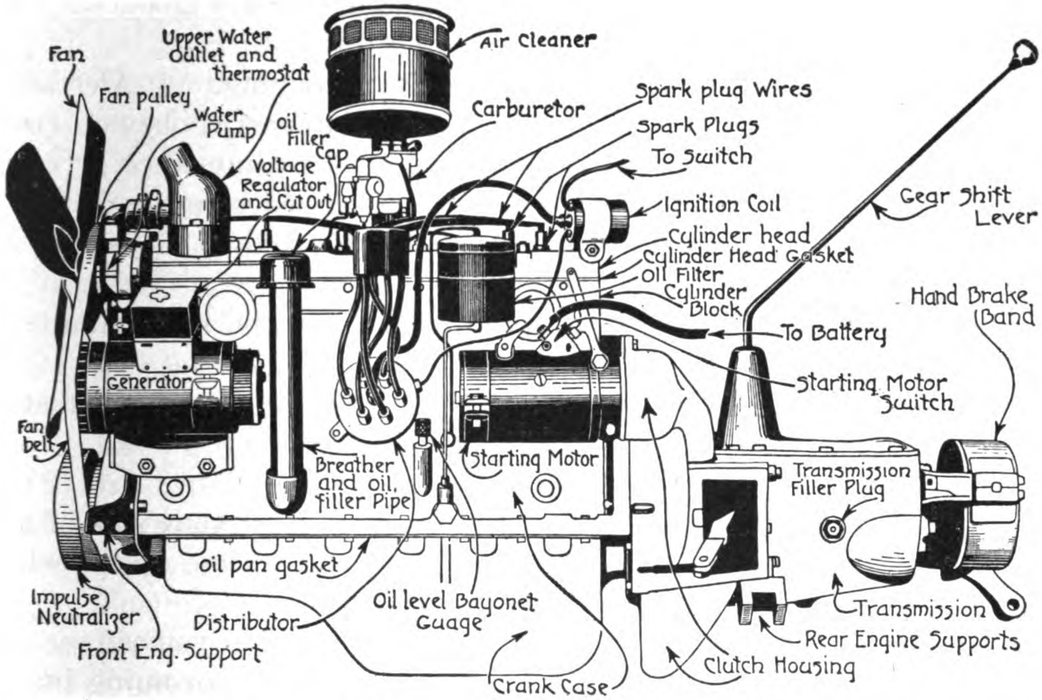


FIGURE 133.—Typical engine and transmission assembly showing external parts, equipment, and accessories.

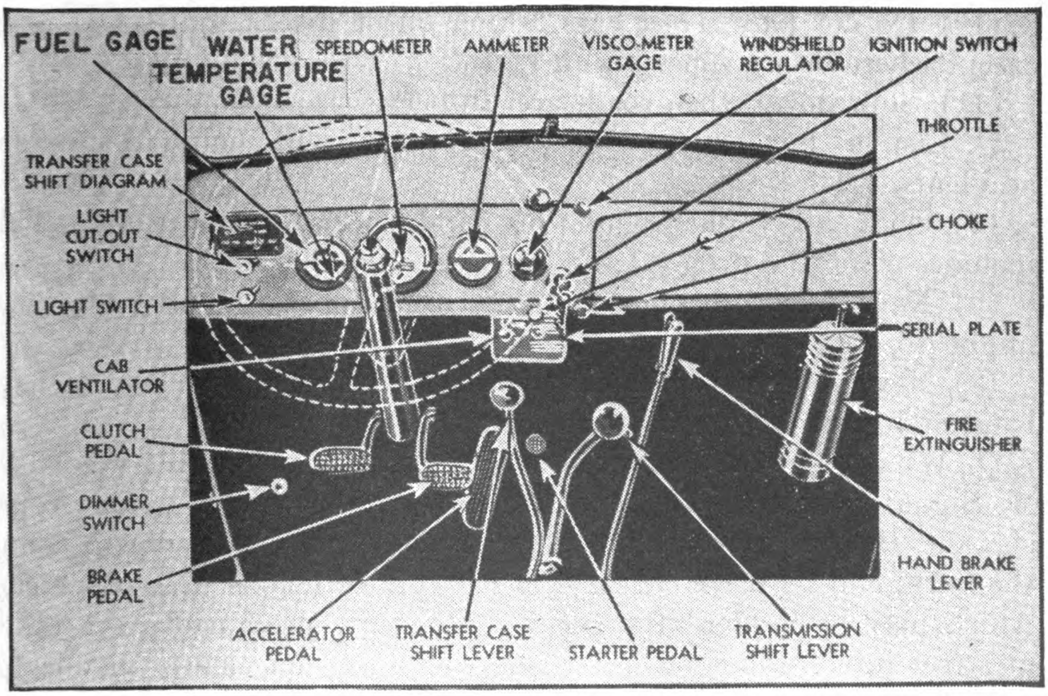


FIGURE 134.—Interior view of truck cab showing instruments and controls.

91. Practical operation of motor vehicles, to include driving and fueling.—*Q*. What are the qualifications for a good driver? *A*. Good physical condition and common sense.

Q. Define "common sense" in connection with driving. *A*. Alertness, judgment, and caution on the road. A good driver will obey all traffic regulations and carry out the rules of good maintenance driving. He will respect the rights of other drivers and of pedestrians.

Q. Mention the most important rules to be observed on the road. *A*.

(1) Have vehicle under control at all times.

(2) Never exceed prescribed speed limits nor the speed limit of your vehicle.

(3) Keep a safe distance in rear of a vehicle in front so you can stop if that vehicle stops suddenly.

(4) Keep on the right side of the road.

(5) Do not try to pass a car parked or moving on your side of the road if a car is approaching from the opposite direction, except when operating on a road having three or more lanes.

(6) Do not try to pass a car on a hill or curve unless you can see the road far enough ahead to assure yourself that no car is coming in the opposite direction.

(7) Sound the horn before passing a car going in the same direction.

(8) Give the proper hand signal before stopping or turning.

(9) Go slowly on sharp curves.

(10) Do not pass street cars taking on or discharging passengers except where safety zones are provided.

(11) Slow down when roads are slippery.

Q. List a few rules whose observance will help to prevent accidents. *A*.

(1) Obey all traffic regulations and special instructions. This includes using the proper hand and horn signals.

(2) Never depend on what the other operator or pedestrian might do.

(3) Never operate a vehicle with faulty brakes, steering mechanisms, or lights.

Q. What precaution is taken before stopping or turning a corner? *A*. Signal to drivers of other vehicles by extending arm in the proper signal. Before turning corners or sharp curves, slow down, sound the horn, and be prepared to stop to avoid collisions with other cars which may be hidden from view. The same precautions are taken at street intersections or crossroads which are not clearly visible for some distance in each direction.

Q. What inspections are required to be made by the driver before leaving and after returning to the garage? *A*.

(1) Oil level in crankcase.

(2) Water in radiator.

(3) Gasoline supply.

(4) Condition of tires and battery.

(5) Inspection for leaks in cooling and oiling systems.

(6) Mechanical condition of vehicle, especially brakes, steering, lights, and horn. Any faults and unusual noise observed during operation should be reported to dispatcher immediately.

Q. Give several common faults in driving which are damaging to the vehicle? *A*.

(1) Racing the engine at any time.

(2) Inadequate use of the gears.

(3) Excessive or improper appliance of the brakes.

(4) Riding, slipping, or quickly engaging the clutch.

(5) Turning front wheel, while standing.

(6) Excessive use of the choke.

(7) Excessive speed in first or second gears.

(8) Continuing to drive with minor maladjustments.

Q. What precautions should the driver take against fire? *A*.

(1) Never refuel while engine is running.

(2) Be careful not to let the fuel tank overflow, as hot exhaust pipe and manifold can readily ignite the fuel.

(3) Keep old, oily rags, waste, and papers from under the seat.

(4) Keep engine clean.

(5) Do not smoke while driving or on the vehicle.

Q. What should be done in case a vehicle catches fire? *A*. If the vehicle is inside a building, push it out, if possible. Use the fire extinguisher that is carried on every Government vehicle, playing it directly on source of fire. Do not use water on a gasoline or oil fire—it only tends to spread the fire. If the fire extinguisher is not sufficient to extinguish the fire, use dirt, sand, or mud; in some cases it can be smothered by using such articles of clothing as may be available. If fire should break out in the load of the vehicle, remove load until the source of the fire can be reached.

Q. What precautions are necessary in cold weather? *A*.

(1) Protect the water in the radiator from freezing.

(2) Watch condition of battery, as it does more work and is less efficient in cold weather.

(3) Use chains or tractioneers when necessary.

(4) Keep off soft or partially frozen ground.

Q. How should radiator be protected in cold weather? *A*. Unless filled with antifreeze the radiator and water jackets should be completely drained, when the vehicle is not in use, and a "drain" sign hung on the radiator. Sometimes it will be necessary to protect the lower front-half of the radiator with tin, cardboard, or canvas.

Q. What precaution should be observed when filling the radiator when engine is very hot? *A*. The engine should be stopped and allowed to cool off before adding water. If time will not allow this, let the engine run while water (preferably warm water) is added slowly.

Q. What is the proper way of applying the foot or service brake? *A*. It must be applied, except in case of emergency, with evenly increasing pressure; as the vehicle comes to a stop the pressure should be progressively reduced to give a smooth stop. Sudden stops are hard on the vehicle and on the brakes and may cause rear end collisions.

Q. How should air brakes be applied? *A*. The best possible stop will be made when the brakes are applied at the very start as hard as the speed and condition of the road will permit, and then eased off as the speed is reduced, so that at the end of the stop but little pressure remains in the brake chambers. In easing the brakes off, do not "fan" the brake valve, repeatedly releasing and applying the brakes, as this wastes air pressure.

Q. What inspection of air brakes should be made before starting the vehicle? *A*. Observe the air pressure gage, showing the pressure stored in the reservoir. It must read 40 pounds or over before the air brakes can develop full effectiveness.

Q. What is the purpose of the hand brake? *A*. To hold the vehicle in a parked position. In emergency to relieve the foot brake. Caution must be exercised in applying the hand brake because if it is of the propeller shaft type a sudden application may strip the rear end gears and the vehicle will be out of control.

Q. What is the purpose of the choke? *A*. To restrict the air passage at the inlet of the carburetor, thereby giving a rich mixture for starting and warming up the engine.

Q. What is the proper use of the choke? *A*. To assist in starting when the engine is cold or the vehicle has been left idle for some time. Excessive use will flood the engine, making starting impossible and interfering with proper lubrication.

Q. What throttle setting should be used for starting? *A*. This depends upon the vehicle. Most carburetors are designed so that the

proper setting for starting is determined by a throttle stop. By stepping on the accelerator a few times before starting, the engine will be primed and should start when the starter is engaged.

Q. What throttle setting should be used until the engine warms up? *A*. A setting corresponding to about 20 mph vehicle speed. The engine should not carry a load during this period.

Q. What is the proper use of the accelerator? *A*. The accelerator should be depressed slowly. Tramping on the accelerator floods the engine, wastes gasoline, and fouls the spark plugs.

Q. What precautions must be taken with the ignition switch? *A*. It must be left locked, whenever the vehicle is parked, to prevent damage to the coil and battery.

Q. How do you select the proper gear? *A*. A gear is selected that will allow the engine to run without lugging. If the engine cannot reach its governed speed, gears should be shifted. When descending grades, a gear must be selected that will not force the engine to run faster than its governed speed.

Q. What damage might result from the improper selection of gears? *A*.

(1) Engine bearings might be damaged or cylinder head gasket blown.

(2) The driver might be forced to shift down two gears and thus delay the convoy.

(3) If on a down grade, the truck might run away or the engine might turn over so fast that it will be damaged.

Q. What is the proper way to shift gears? *A*. Bring the engine to full governed speed in each gear as the shift is accomplished.

Q. Explain double-clutching and its purpose. *A*. Double-clutching is accomplished by engaging the clutch while the transmission hesitates in neutral when the gears are being shifted up or down, then shifting to the next gear in the normal manner. During the hesitation period the foot is removed from the throttle, if the shift is from a lower to a higher gear; if from a higher to a lower gear, the engine is speeded up to the speed that it should be running in the lower gear selected. Double-clutching is useful in shifting from a lower to a higher gear on trucks that are hard to shift. It is useful in changing to a lower gear preparatory to descending a grade. Double-clutching has its limitations, and the driver must not wait until it is too late to shift. (All drivers should be required to shift from a higher to a lower gear without clashing gears.)

Q. Can front-wheel drive clutches be used while the vehicle is in motion? *A*. Yes. Levers must not be forced. In some instances the

front wheels may have to be turned to allow shifting dogs to come into line. (Drivers of all vehicles should be required to master these special shifting devices.)

Q. What is an auxiliary transmission? *A.* An over-, under-, and direct-drive gearing used in conjunction with the transmission.

Q. How is an auxiliary transmission operated? *A.* When operating under ordinary road and load conditions, it is placed in direct-drive position. When operating under difficult road conditions or over

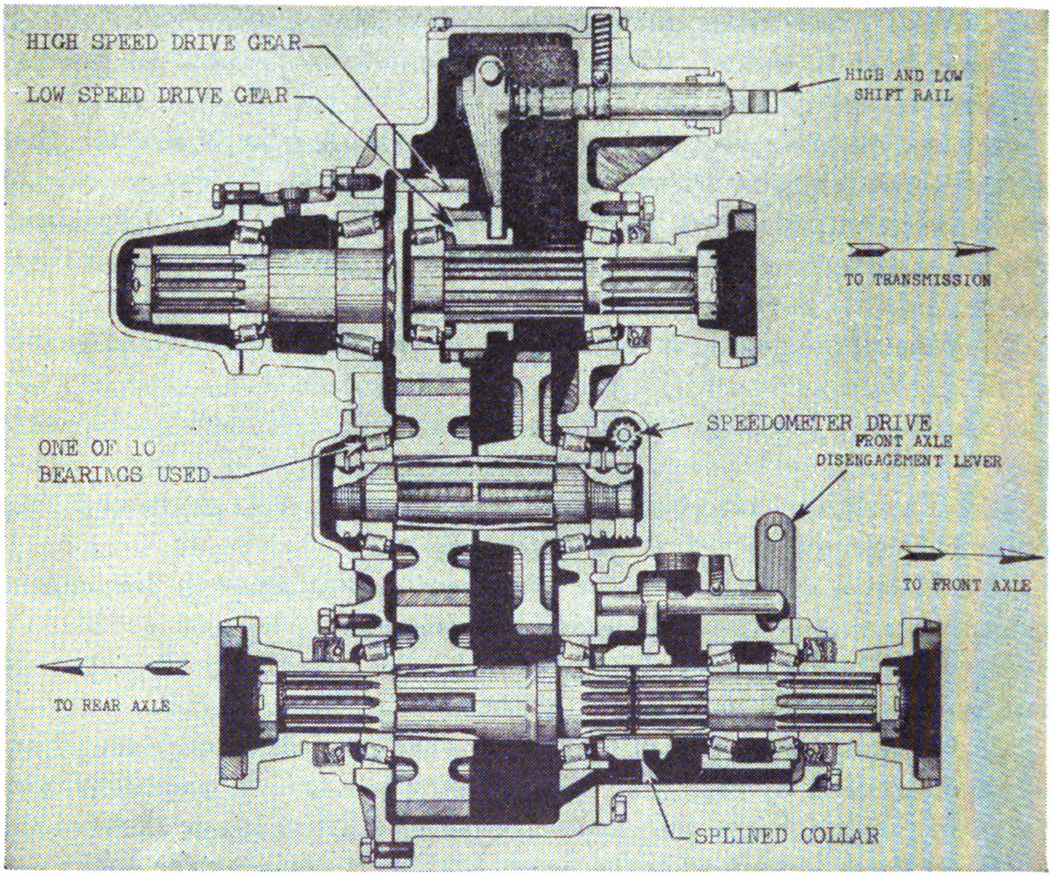


FIGURE 135.—Typical two-speed transfer case showing relation to driving and driven units and disengaging features for front axle.

uneven roads or steep grades with capacity loads, it is placed in the under-drive position. When operating over level roads with light loads, it may be placed in the over-drive position to give maximum road speed without excessive engine speed.

Caution: The auxiliary transmission must never be shifted while vehicle is in motion.

Q. How is a car brought back to the center of the road after beginning to skid on a wet pavement or muddy road? *A.* When the rear of the car starts to skid, turn the steering wheel in the direction the car

is skidding and partially close the throttle. To close the throttle entirely would have the same effect as applying the brakes. Do not apply the brakes. When skidding on a narrow road, it is best to apply more power and steer for the center of the road. This will aggravate the skid for a moment but will bring the car around at an angle with the front wheels in the center of the road. The momentum of the car will cause the rear wheels to climb back onto the road.

Q. What is the normal operating temperature of a gasoline engine? *A.* Approximately 180° F.

Q. Where is this temperature taken? *A.* In the water that surrounds the cylinders and combustion chambers of the engine.

Q. What data are usually found on the dash plate? *A.* Make and model of vehicle, maximum speed, tonnage that the vehicle was designed to carry, engine number, serial number, and date of manufacture.

Q. How should a vehicle be loaded? *A.* The load should be distributed equally, fore and aft, and to the right and left, of the center of gravity of the vehicle. Heavy items are placed on the bottom of the load. It should be systematically loaded to facilitate delivery. Any load beyond the capacity of the vehicle should be refused. The load should be properly secured by lashing or some other means. Red flags or lanterns must be attached to all loads protruding beyond the truck body.

Q. How can the driver tell if the vehicle is overloaded? *A.* By noting the set of the springs.

The candidate will be required to—

(1) Start the engine of a truck or car.

(2) Start in first gear, shift into second and third gears.

(3) Shift back into second gear.

(4) Stop the vehicle.

(5) Shift into reverse gear and back the vehicle.

(6) Shift into neutral and stop engine.

92. Trouble shooting and minor repairs.—*Q.* What is the most usual cause of engine trouble? *A.* Ignition. In the field, dirt and water in fuel run ignition trouble a close second.

Q. Before making a detailed investigation of engine trouble what tests should be made? *A.*

(1) That clean gasoline is reaching the cylinders. If in doubt the cylinders should be primed.

(2) That the spark is occurring and all wires are attached.

(3) That compression is satisfactory as tested with the crank.

(4) That ignition timing is approximately correct.

Q. How can a check be made that gasoline is reaching the cylinders? *A*. Disconnect the gasoline line at the carburetor, turn the engine over, and see if gasoline is pumped from the line.

Q. How can it be determined if a spark is occurring? *A*. Turn on ignition, remove one of the spark plug wires, and hold it by its insulation a short distance from the engine; turn the engine over and note if spark occurs.

Q. How can it be determined if ignition timing is approximately correct? *A*. Remove a spark plug but leave its wire attached and remove valve cover. Through spark plug hole note when piston is at top dead center and at the same time note when both valves are closed. Continue to turn engine over slowly and note when spark occurs. To be correct, spark should occur at or near top dead center with both valves closed.

Q. If the four basic tests are positive but the engine still refuses to start, what may be the trouble? *A*.

(1) Engine flooded.
(2) Choke not working.
(3) Carburetor frozen.
(4) Engine too cold.
(5) Valve sticking open.
(6) Valve spring broken.
(7) Spark plugs dirty or with too wide a gap.
(8) Poor gasoline.
(9) Wiring out of order.
(10) Wet ignition system.
(11) Battery too weak.
(12) Throttle levers disconnected.
(13) Carburetor jet plugged.
(14) Condenser weak.
(15) Oil too heavy.
(16) Blocked muffler.

Q. What does light blue smoke from the muffler indicate? *A*. Burning of oil for some reason.

Q. What does steam from the exhaust indicate? *A*. A water leak due to a blown gasket or cracked engine.

Q. What does black smoke from the exhaust indicate? *A*. Too rich a mixture. Engine will be sluggish when this condition exists.

Q. How does the driver generally locate trouble? *A*. By inspections, generally during operation.

Q. What repair parts should the driver carry? *A*. Tape, wire, tire

patching outfit, extra spark plug, and such extra parts as past experience has shown are liable to frequent failure.

Q. What should the driver do when his vehicle is being repaired? *A*. He should assist the mechanic and point out past troubles.

Q. Before performing any repairs what should be done? *A*. The motor vehicle instruction book should be consulted.

Q. What are indications of steering trouble? *A*.

(1) Play or rattle in a steering gear.

(2) Shimmy.

(3) Peculiar or rapid tire wear.

(4) Hard steering.

Q. What does backfiring indicate? *A*.

(1) A lean mixture.

(2) Carburetor or fuel trouble.

(3) Overheating of engine.

(4) Stuck valves.

(5) Retarded spark.

Q. Name some clutch troubles which should be reported? *A*. Slipping, grabbing, noisy clutch, clutch that will not release.

Q. When do brakes need adjustment or repair? *A*. When they will not stop the vehicle within 30 feet from 20 mph on a dry, smooth, level road.

Q. When should repairs be made to a vehicle? *A*. As soon as they can be done competently.

Q. What is needed to find trouble on a motor vehicle? *A*. A set of testing equipment such as is furnished for the use of each battery.

93. Duties of driver in care, service, repair, and maintenance of motor vehicles.—*Q*. What defines the duties of the driver? *A*. FM 25–10, Technical Manuals of the 10 series, AR 850–15, Circulars 1–10, O. Q. M. G., and the motor vehicle manual issued with each vehicle.

Q. How are drivers selected? *A*. On the basis of their standing in an examination on the course of instruction laid down in FM 25–10.

Q. What are the responsibilities of the driver? *A*.

(1) Operation and maintenance of motor vehicles in accordance with instructions.

(2) Care and condition of vehicle, tools, and equipment.

(3) Loads and loading.

(4) Reports and records.

Q. With what should the driver be thoroughly familiar? *A*.

(1) Fire precautions and fire fighting methods.

(2) Accident prevention.

(3) Purpose of the major units of the motor vehicle.
(4) Motor vehicle controls.
(5) Inspections.
(6) Maintenance.
(7) That part of the motor vehicle manual that pertains to the driver.

Q. What may be used to fight a gasoline fire? *A*. Sand or a special extinguisher of the foam, CO_2, or carbon tetrachloride type. Never use water.

Q. How is the vehicle fire extinguisher used? *A*. By removing it from its bracket, unlocking it, and pumping. The stream of liquid must be directed at the top or to the windy side of the flame since the liquid releases a gas which is heavier than air. ***Caution:*** This gas is harmful to breathe.

Q. Where are motor vehicle keys kept when the vehicle is in the garage? *A*. They are kept in the vehicles or on a plainly marked board nearby so that vehicles may be moved quickly in case of fire.

Q. May the driver remove gasoline from his fuel tank? *A*. No. The regulations forbid the use of gasoline for cleaning purposes. Gasoline for all authorized purposes may be obtained on a regular issue slip.

Q. For what accidents are drivers responsible? *A*. All accidents that occur to their vehicles while in motion, when parked in an unauthorized place, or when being worked on by themselves.

Q. Define first echelon maintenance. *A*. First echelon maintenance includes all the maintenance functions required to be performed by the driver and his assistant, using only the tools and spare parts on his truck. It is divided into three parts: inspection, preventive maintenance, and repairs.

Q. What inspections are required to be made by the driver? *A*.
(1) *During operation.*
(*a*) Note abnormal readings of dash gages.
(*b*) Note unusual engine sounds.
(2) *At the halt.*
(*a*) Check for fuel, oil, and water leaks.
(*b*) Check tires, tracks, and traction devices.
(*c*) Check for overheating of mechanical units such as brake bands, transmission, etc.
(*d*) Check lights, horn, windshield wiper, etc.
(*e*) Inspect cargo.
(3) *After operation.*
(*a*) Check all items noted in (2) above.

(*b*) Check for loose parts or linkages.

(*c*) Check tools and equipment.

(4) Report results of inspection in each case to the truckmaster.

Q. For what type of maintenance is the driver responsible? *A*. Scheduled, operating, and precautionary maintenance.

Q. What is scheduled maintenance? *A*. Cleaning, lubrication (except when done by a service department), tire care, battery care (except when done by a battery expert), minor repairs, checking of fuel, air, oil, antifreeze, and water.

Q. What constitutes operating maintenance? *A*. Loading, speed, proper use of controls, emergency repairs.

Q. What constitutes precautionary maintenance? *A*. Minor repairs performed as the result of inspections.

Q. What repairs and adjustments may the driver make? *A*. Except for repairing tires and emergency roadside repairs the driver is not permitted to make any repairs or adjustments except under the supervision of the truckmaster.

Q. What maintenance must be performed by the driver on an air-brake system? *A*. Drain the reservoir, daily in cold weather and weekly in warm weather, by opening the drain cock on the bottom. This allows any water collected in the reservoir to run out. *Be sure to close the drain cock after the water has been removed.*

Q. How is the proper spark setting determined? *A*. If the engine runs with full power without knocking, the spark setting is satisfactory.

Q. What care must be taken of the clutch? *A*.

(1) The clutch must not be slipped; gears should be used instead.

(2) When the clutch needs adjustment a prompt report should be made to the motor sergeant.

(3) The clutch must not be let out suddenly or damage to the whole vehicle will result.

(4) The clutch must be properly lubricated but must not be over-lubricated or it will slip.

Q. What general precautions will be taken by the driver when working on his vehicle? *A*.

(1) He will not start the engine unless the controls are in neutral.

(2) When working under a truck, he will not depend upon jacks but see that the vehicle is firmly blocked.

(3) To lessen the danger of fire remove the battery in case of doubt or major repair.

(4) He will work in a well-ventilated place.

Q. How does the driver get needed repairs done to his vehicle? *A*.

He turns in a bad order report to his truckmaster. The report may be either written or oral.

Q. What records must the driver keep? *A.* Accident report, trip ticket, bad order report, and in some cases an issue slip and vehicle log. These records are kept as directed by the truckmaster.

Q. What kind of oil should be added to the crankcase? *A.* The kind recommended in the instruction manual accompanying the vehicle.

94. Convoy and march rules and discipline.—*Q.* What is a convoy? *A.* A group of two or more military motor vehicles moving as a unit under competent military authority.

Q. What is the purpose of a convoy? *A.* The efficient transportation of personnel and material especially with respect to time required and condition upon arrival.

Q. What is the assigned minimum distance for trucks in convoy? *A.*

(1) Open formation: 100 yards.

(2) Closed formation: Twice the speedometer reading in yards.

(3) At halt: 2 yards.

(4) Between sections: 3 to 5 minutes driving time.

Q. Describe drivers' arm signals. *A.*

(1) *Turn right.*—Extend the left arm outward at an angle of 45° above the horizontal.

(2) *Turn left.*—Extend the left arm outward horizontally.

(3) *Slow or stop.*—Extend the left arm outward to an angle of 45° below the horizontal.

(4) *Pass and keep going.*—Extend the left arm horizontally and describe small circles toward the front with the hand.

Q. Describe the commands and signals commonly used in a motorized unit. *A.*

(1) *Start engine.*—Simulate cranking.

(2) *Ready to start.*—Senior in truck stands on running board, faces leader, and extends arm vertically, fingers extended and joined, palm toward the leader.

(3) *Stop engines.*—Cross arms in front of body at the waist and then move them sharply to the side. Repeat several times.

(4) *Increase speed.*—Carry closed fist to the shoulder and rapidly thrust it vertically upward several times to the full extent of the arm.

(5) *Close up.*—Extend the arms horizontally straight to the front, palms in. Move the hands together and then resume the first position. Repeat several times.

(6) *Open up.*—Extend the arms horizontally, straight to the front, palms out. Move the hands outward and then resume the first position. Repeat several times.

(7) *Danger.*—Use three long blasts of a whistle or automobile horn repeated several times or three equally spaced shots with a rifle or pistol. The person giving the signal points in the direction of impending danger. This signal is reserved for warning of air or mechanized attack, or other immediate and grave danger. Other signals may be found in FM 25-10.

Q. What are the driver's principal duties during a convoy? *A.*

(1) Attention to orders and to his driving.

(2) Constant inspection before, during, and after operation.

Q. What should the driver do if he has any trouble when the convoy is on the march? *A.* If it is a major trouble he should pull to the side of the road and signal the following vehicle to pass. He should then report his trouble to the maintenance officer, who is at the rear of the convoy. If left behind the driver will remain with his truck as a guard.

If it is a minor trouble, he will report it to the section mechanic or maintenance officer at the next halt.

Q. What should the driver do during halts of a convoy? *A.*

(1) He should make the inspections prescribed.

(2) He should keep to the right of his vehicle.

Q. What are the duties of the assistant driver during a convoy? *A.*

(1) He assists the driver in backing, parking, etc.

(2) He watches to the rear.

(3) He takes his turn at driving.

(4) He assists in first echelon maintenance.

Q. How is gasoline obtained on convoy? *A.*

(1) In an emergency, from 10-gallon cans carried with the convoy.

(2) At halts, from tankers or some type of filling station.

95. Handling of trucks under adverse conditions.—*Q.* What equipment is furnished each truck and tractor for this purpose? *A.* One tool set (complete with tools) and pioneer equipment motor vehicle set No. 1. This set consists of a shovel, pickmattock, an ax, and a bracket to carry them. One set of chains and in some cases traction devices are also furnished.

Q. What other equipment is available? *A.* The maintenance section has a block and tackle set, a wrecking set, towbars, and rope. Some vehicles are equipped with power driven winches, and all vehicles are equipped with towhooks and pintles.

Q. In applying chains what precautions must be taken? *A.* They

must be adjusted properly. In the case of all-wheel drive vehicles they must be placed on all wheels, or broken axles will result.

Q. In case vehicle gets stalled what should be done? *A*. The driver or the assistant driver will investigate the reason for stalling and make a plan as to how best to get out of the position. If the decision of some one in authority is that a wrecker is needed, one will be summoned.

Q. What four abilities must a motor vehicle have to get out of or keep going in a difficult situation? *A*.

(1) *Power.*—All new trucks issued to the service have enough power.

(2) *Momentum.*—This depends on the speed of the vehicle. In some cases too much speed causes the vehicle to lose part of its traction, resulting in spinning of the wheels. If this occurs, the vehicle may become badly stalled.

(3) *Traction.*—All of the multiwheel vehicles are designed to give great traction.

(4) *Flotation.*—This is the ability of the vehicle to ride the ground surface.

Q. How should a difficult hill be negotiated? *A*. On approaching, a sufficiently low gear should be selected to negotiate the hill, and maximum practicable momentum should be obtained. If in column do not start up the hill until the truck ahead has negotiated it. In case of failure, back down in gear. ***Caution:*** Check to see if brakes hold before shifting to reverse gear, and take steps to enable the truck to climb the grade; for example, lower gear, use of traction devices, or tow from a tractor.

Q. What is a prolonge? *A*. It is a rope with a hook or loop on one end used to maneuver a vehicle by manpower. Prolonges are usually used in pairs.

Q. How should very steep, dangerous slopes be descended? *A*. Straight down, with all personnel except the driver dismounted. Gears should be used, and if brakes are also needed care must be exercised to prevent locking of the wheels. The ignition should not be turned off. Outside assistance may be needed; for example, block and tackle, winch, or prolonges.

Q. What is the best way to negotiate mud? *A*.

(1) Maintain momentum.
(2) Use highest gear possible.
(3) Apply power gently to prevent wheel slippage.
(4) Use traction devices.
(5) Use care in selecting track.

Q. In case a vehicle becomes stalled in mud what should be done? *A*.

(1) If loaded with personnel have them dismount and push. Sometimes backing up and selecting another way out will solve the problem.

(2) Use a tow.

Caution: Because of the danger of slipping under the vehicle, personnel should be cautioned against pushing on the side of a moving vehicle that has slipped into a ditch or old wheel ruts.

Q. In case of operating alone what is done if the vehicle becomes stalled? *A*.

(1) Traction may be improved by means of wheel mats, brush, or boards.

(2) The truck may be dug out.

(3) If the vehicle has dual wheels a rope may be used between the wheels; the truck will wind the rope up like a windlass.

(4) A pole may be inserted between the wheels that are slipping. This method is very effective on track-laying vehicles.

Q. What is the most useful device furnished the Coast Artillery for negotiating difficult terrain? *A*. The power-driven winch on tractors and gun trucks.

Q. How is sand negotiated? *A*.

(1) By the use of traction devices.

(2) By using the same track.

(3) By making roads from chicken wire or brush.

Q. In case skidding occurs what should be done? *A*. The accelerator should be released gradually and the front wheels turned in the same direction that the rear wheels are skidding. Where necessary, prolonges may be used to prevent skidding in very slippery places.

Q. How is a narrow ditch crossed? *A*.

(1) Small ditches, less than the diameter of the tire, or wider shallow ditches should be crossed at an angle. Since this puts a strain on the vehicle the load should be lightened if possible, and personnel should assist at the critical point.

(2) Wide ditches must be filled or bridged before crossing. They are crossed at right angles.

Q. How are shallow streams forded? *A*. Slowly in a low gear.

Q. What precautions should be observed in crossing bridges? *A*.

(1) The speed and load signs should be observed.

(2) When the capacity of the bridge is not sufficient, the towed load can be pulled across separately.

(3) Track-laying vehicles should be started across so that they do not have to turn.

(4) Brakes should not be used.

Q. When towing over difficult terrain, what precautions must be taken? *A*. If possible, apply the brakes on the tow before applying those of the vehicle. Most vehicles designed for towing now provide means to do this.

Q. If a turn is too sharp for a towed load what may be done? *A*. The tow may be uncoupled and negotiated around the bend with winch or block and tackle.

Q. In case a vehicle overturns what is done? *A*. Remove the load and await a maintenance crew with block and tackle and wrecking set.

Q. What is the best way to keep a vehicle from becoming stalled or mired? *A*. Follow a reconnoitered route and make a careful inspection of all doubtful places before attempting to negotiate them.

96. Operation of vehicle not in convoy.—*Q*. When a driver is to make a trip not in convoy, what orders does he receive? *A*. He receives a properly filled out "Driver's Trip Ticket and Performance Record," plus such verbal instructions as may be necessary.

Q. What is the purpose of a "Special Order" directing a driver to complete a certain trip? *A*. In peacetime the driver of a vehicle not in convoy on an extended trip needs a special order so that he may obtain rations, supplies, fuel, ferriage, etc.

Q. How does the driver obtain rations on a trip not in convoy? *A*. He may take rations in kind, ration with some other organization, or he may be furnished cash in advance in lieu of rations.

Q. How does the driver obtain spare parts or get his vehicle repaired? *A*. If possible, at the nearest Army post; if not, he may have the work done by a local authorized dealer for the type of vehicle he is driving. To provide for the latter case he should be provided, before starting, with the proper forms showing the method of billing. The regimental transportation sergeant will instruct the driver as to the proper procedure.

Q. How are fuel and lubricants obtained by the individual driver? *A*. From Army posts en route by simply signing issue slips. By the use of tax-exemption certificates, they may be obtained from private dealers. These certificates must be carried by the driver. In some cases courtesy cards are furnished by oil companies.

Q. In case of accident what does the driver do? *A*.

(1) Renders aid to any injured.

(2) If possible he carefully fills out accident report and obtains names and addresses and statements from all available witnesses.

(3) Notifies local police.

Q. What should the driver do in case the person who ordered the vehicle cannot be found? *A*. He waits a reasonable time at the spot where he was told to report and then reports back to the dispatcher.

Q. Should the individual driver pass a moving convoy? *A*. Not unless ordered to do so by competent authority.

Q. How are locations found in the United States? *A*. By following marked routes with the aid of a road map.

Q. In case the driver feels sleepy what should he do? *A*. Pull to the side of the road and take a rest unless there is an assistant driver to take over.

CHAPTER 10

DEFINITIONS

SECTION I

ELEMENTARY DEFINITIONS FOR SEACOAST ARTILLERY

97. Definitions.

Adjustment of fire.—The process of determining and applying corrections to the firing data to bring the center of impact to the adjusting point and to keep it there.

Aerial observation.—Observation of fire from aircraft.

Aiming point.—The point on which the gun pointer sights when pointing the gun.

Altitude.—The vertical distance above or below a specified datum level, usually sea level at mean low water. It is sometimes called height of site.

Angle of departure.—The vertical angle between the line from the gun to the target and the axis of the bore when the projectile leaves the muzzle.

Angle of elevation.—The vertical angle between the line from the gun to the target and the axis of the bore when the piece is pointed in elevation.

Angle of jump.—The angle between the line of departure and the line of elevation. Its component in the vertical plane is called the vertical jump and its component in the horizontal plane is called the lateral jump.

Axial observation.—Observation of fire from a point on or near the gun-target line. Observation is said to be axial when the observing angle is 5° or less.

Axis of the bore.—The center line of the bore of the cannon.

Axis of trunnions.—The axis about which a cannon is rotated in elevation.

Azimuth.—The horizontal angle, measured in a clockwise direction, from a selected reference line (usually grid south) passing through the position of the observer to the horizontal projection of the line of sight from the observer to the objective.

Azimuth difference.—The difference, due to displacement, between the azimuths of a point as measured from two other points; or the angle subtended at the point in question by a line connecting the two other points. It is also called parallax.

Backlash.—The lost motion or play in a mechanical system.

Base line.—A line of known length and direction between two observation stations or two spotting stations, the positions of which with respect to the battery are known.

Battery manning table.—A table containing a list of names detailing the personnel of a battery to their posts.

Battle chart.—A chart used in a group or a higher command station, showing the water area covered by the armament of that command.

Bilateral observation.—Observation of fire from two observation stations.

Cant.—The angle made with the horizontal by the axis of the trunnions.

Center of dispersion.—*See* Dispersion.

Center of impact.—The point whose deviation is the mean of the deviations of the several shots of a series.

Conduct of fire.—The employment of technical means to place accurate fire on a target. Fire is usually conducted by the battery which is the normal fire unit.

Corrected azimuth.—The azimuth from the directing point to the target corrected for all known variations from those conditions assumed as standard in the construction of firing tables.

Corrected deflection.—The deflection corrected for all known variations from those conditions assumed as standard in the construction of firing tables.

Corrected elevation.—The firing table elevation corresponding to the corrected range.

Corrected range.—The range corrected for all known variations from those conditions assumed as standard in the construction of firing tables.

Datum level.—A spherical surface which represents mean sea level or other specified reference level from which altitudes are measured.

Datum point.—A fixed point, the azimuth and range of which have been accurately determined from one or more observation stations or other positions.

Deflection.—The horizontal angle between the line of sight to the target and the axis of the bore when the piece is pointed in direction. It is usually expressed in reference numbers and is set on the sight. The deflection due to travel alone is called the uncorrected deflection.

Deviation.—The distance of a point of impact or center of impact from the center of the target. If a set of axes is drawn through the target, the Y axis being along the gun-target line and the X axis is perpendicular to the Y axis, then the Y coordinate of the point of impact is called the longitudinal (or range) deviation and the X coordinate is called the lateral deviation. The shortest distance from the center of the target to the point of impact is called the absolute deviation.

Direct pointing.—Pointing a gun in direction or in both range and direction by means of a sight directed at the target.

Directing point.—The point in or near a battery for which the firing data are computed. If a gun of the battery is the directing point, it is called the base piece or directing gun.

Dispersion.—The scattering of shots fired with the same data. The area over which the shots are scattered is called the zone of dispersion. The center of that area is called the center of dispersion.

Displacement.—The displacement of one point from another is the distance between these points. Gun displacement is the horizontal distance in yards from the pintle center of the gun to the directing point or directing gun of the battery.

Drift.—The divergence of a projectile, due to its rotation and the resistance of the air, from the vertical plane containing the line of departure. It may be expressed in either linear or angular units.

NOTE.—The drift listed in firing tables includes lateral jump.

Elevation.—*See* Angle of elevation; Quadrant elevation.

Elevation difference.—The angular units of quadrant elevation corresponding to a particular gun difference for a particular range.

Elevation table.—A table of ranges with corresponding quadrant elevations, used in graduating, and in checking the graduations of, the range disk of a fixed cannon. The quadrant elevations listed are firing table elevations corrected for height of site.

Field of fire.—That portion of the terrain or water area covered by the fire of a gun or battery.

Fire control.—The exercise of fire direction and conduct of fire.

Fire-control installation.—The equipment which is employed in the fire control of any unit.

Fire direction.—The exercise of the tactical command of one or more units in the selection of objectives and in the concentration or distribution of fire thereon at the appropriate times.

Fire discipline.—The efficiency of the personnel in action which involves accuracy and alertness resulting from organization, drill, and coordinated effort.

Fire for effect.—Any fire conducted against a hostile target.

Firing azimuth.—The azimuth at which the gun is pointed for firing.

Firing data.—All data necessary for firing a gun at a given objective.

Firing elevation.—The firing table elevation corresponding to the firing range.

Firing range.—The range at which the gun is pointed for firing.

Firing tables.—A collection of data, chiefly in tabular form, intended to furnish the ballistic information necessary for conducting the fire of a particular model of cannon with specified ammunition.

Fixed armament.—Seacoast artillery weapons that are emplaced in permanent firing positions.

Flank observation.—Observation of fire from a point where the observing angle is greater than 75°.

Fuze.—A device attached to a projectile which controls the time of burst of the projectile.

Gun difference.—The difference, due to displacement, between the range from a gun to the target and the range from the directing point to the target.

Gun displacement.—*See* Displacement.

Gun parallax.—The azimuth difference between the line from the directing point to the target and the line from the gun to the target.

Gunner's quadrant.—An instrument used on the quadrant seat of a gun to measure the vertical angle between the axis of the bore and the horizontal.

Gunnery.—The practice of firing guns. It includes a study of the flight of the projectile and of the technical considerations involved in the conduct of fire.

Height of site.—*See* Altitude.

High-angle fire.—Fire delivered at quadrant elevations greater than the elevation corresponding to the maximum range. In high-angle fire the range decreases as the quadrant elevation is increased.

Horizontal base system.—A system of position finding in which the target is located from two observation stations.

Indirect fire.—Fire conducted with indirect pointing.

Indirect pointing.—Pointing a gun in direction by the use of a sight and an aiming point other than the target, or by the azimuth circle on the carriage, and in elevation by range drum or quadrant.

Jump.—*See* Angle of jump.

Lateral deviation.—*See* Deviation.

Lateral jump.—*See* Angle of jump.

Leveling.—The process of adjusting the gun and mount or an instrument so that all vertical or horizontal angles will be measured in true vertical or horizontal planes.

Line of departure.—The prolongation of the axis of the bore as the projectile leaves the muzzle of the gun. It is the tangent to the trajectory at the origin.

Line of elevation.—The prolongation of the axis of the bore when the gun is pointed.

Line of position.—The line of position (line of site) of a point is the straight line connecting the origin with that point. The point of origin is usually a gun or a position-finding instrument.

Line of sight.—The line of vision; the optical axis of an observation instrument.

Line of site.—*See* Line of position.

Longitudinal deviation.—*See* Deviation.

Low-angle fire.—Fire delivered at quadrant elevations at and below the elevation corresponding to the maximum range.

Maximum ordinate.—The difference in altitude between the gun and the highest point of the trajectory.

Meteorological datum plane.—The plane assumed as a basis or starting point for the data furnished to the artillery concerning atmospheric conditions. Its altitude is that of the meteorological station.

Meteorological message.—A coded message containing the data, relative to atmospheric conditions, which are required by artillery units.

Mobile armament.—Weapons that may be moved to and emplaced in temporary firing position. In seacoast artillery this class consists of railway, truck-drawn, and tractor-drawn artillery.

Muzzle velocity.—The velocity of a projectile at the muzzle. It is also called the initial velocity.

Normal of a scale.—The reference number that represents a true setting of zero.

Observing angle.—The angle between the observing line and the gun-target line.

Observing line.—The line joining the observer and the observing point.

Observing point.—The point on which the observer sights.

Orientation.—(1) The determination of the horizontal and vertical location of points and the establishment of orienting lines.

(2) The adjustment of the azimuth circle of a gun or of an instrument to read correct azimuths.

Orienting line.—A line of known direction over one point of which it is possible to place an angle-measuring instrument.

Parallax.—*See* Azimuth difference.

Pintle center.—The vertical axis about which a gun and its carriage are traversed.

Point of impact.—The point where the projectile first strikes the ground or other material object.

Position finding.—The process of determining the position of a target with relation to the battery and the determination of a future position upon which to direct the fire.

Predicted point.—The point at which it is expected the target will arrive at the end of the dead time.

Predicting.—The process of determining the expected position of the target at some future time.

Predicting interval.—The interval between successive predictions of future positions of the target.

Primary armament.—Seacoast artillery weapons of 12-inch or greater caliber, and submarine mines.

Probable error.—The error which is as likely as not to be exceeded. A value which will in the long run be exceeded half the time and not exceeded half the time.

Quadrant elevation.—The vertical angle between the horizontal and the axis of the bore when the gun is pointed in elevation.

Range.—The horizontal distance from the gun, observation station, or directing point of a battery to the target, splash, datum point, or other specified point.

Range deviation.—*See* Deviation.

Range difference.—The difference, due to displacement, between the ranges from any two points to a third point.

Relocation.—The process of determining the range and the azimuth from one station to the target (or other point) when the range and the azimuth from another station to the target (or other point) are known.

Round.—All of the component parts of ammunition necessary in the firing of one shot.

Salvo.—One shot per gun, fired simultaneously or in a certain order with a specified time interval between rounds.

Seacoast artillery.—All artillery weapons used primarily for fire upon hostile naval vessels. It includes both fixed and mobile armament.

Secondary armament.—Seacoast artillery weapons of less than 12-inch caliber.

Self-contained base system.—A system of position finding in which the target is located in azimuth and range from a single station using a self-contained range finder.

Self-contained range finder.—An instrument used to obtain ranges by either the stereoscopic or the coincidence principle.

Sense.—The direction of a point of impact (or center of impact of a salvo) with respect to the target, that is, over or short, right or left.

Set-forward point.—A point on the expected course of the target at which it is predicted the target will arrive at the end of the time of flight.

Sight.—A device by which the gun pointer gives the gun the proper direction for firing. It is also called a telescope.

Sound ranging.—The process of locating a target by means of the sounds emitted.

Spotting.—The process of determining the position of a point of impact or burst with respect to the adjusting point.

Subareas.—Subdivisions of the water area in the field of fire, used to assist in the indication, identification, and assignment of targets.

Time interval.—The interval of time between two successive observations made on a moving target during continuous tracking.

Time of flight.—The elapsed time from the instant a projectile leaves the muzzle to the instant of impact or to the instant of burst.

Trajectory.—The curve described by the center of gravity of the projectile in flight.

Trial shots.—Shots fired at a fixed point or target during trial fire.

Uncorrected deflection.—*See* Deflection.

Unilateral observation.—Observation from a station so located that the angle battery-target-station is between 5 and 75°.

Vertical base system.—A system of position finding for moving targets which uses only one observation station equipped with a depression position finder.

Vertical jump.—*See* Angle of jump.

Zone.—When used with reference to mortar fire or to fire from guns or howitzers using more than one size powder charge, it refers to the area in which projectiles will fall when one particular size powder charge is used and the elevation is varied from the minimum to the maximum.

Zone of dispersion.—*See* Dispersion.

SECTION II

ELEMENTARY DEFINITIONS FOR ANTIAIRCRAFT ARTILLERY

Paragraph

98. General.—The definitions listed in this section are intended to give a general knowledge of elements of data and terms applicable to antiaircraft artillery.

Adjustment of fire.—The process of determining and applying corrections to firing data to bring the center of burst, or the cone of fire, to the adjusting point and to keep it there.

Altitude.—The vertical distance to a point in space from a horizontal reference plane, usually the horizontal plane containing the directing point of the battery.

Angular height.—The vertical angle between the line of position (site) and the horizontal.

Azimuth.—The horizontal angle, measured in a clockwise direction, from a selected reference line (usually the grid north line) passing through the position of the observer to the horizontal projection of the line of sight from the observer to the objective.

Back azimuth.—The azimuth plus or minus 180° or 3,200 mils. The opposite direction.

Base line.—A line of known length and direction between the primary (battery) and one of the secondary (flank) observation or spotting stations, the position of which with respect to the battery is known. The base line is called *right-handed* or *left-handed*, depending on whether the secondary station is to the right or left of the primary station from the point of view of a person facing the field of fire.

Base piece.—*See* Directing point.

Bore.—The interior of a gun or cannon forward of the front face of the breechblock (or bolt). The length of the bore is the distance from the front face of the breechblock proper to the muzzle, measured along the axis of the bore.

Center of burst.—The mean position in space of a particular series of bursts.

Dead time.—The time necessary to compute and utilize an element of the firing data.

Deflection.—The angular amount by which the gun must lead the target at the instant of firing in order to hit the target.

Degree.—A unit of angular measure: A circle is divided into 360°. (*See also* Mil.)

Deviation.—The angular or linear displacement of (1) a point of burst or a center of burst, or (2) the center of a cone of fire, from the target or adjusting point.

Directing point.—A point in or near a battery for which the firing data are computed. If a gun of the battery is the directing point, it is called the *base piece* or *directing gun.*

Dispersion.—The scattering of shots fired with the same data.

Displacement.—The distance from one point to another point. Gun displacement is the horizontal distance in yards from the pintle center of the gun to the directing point or directing gun of the battery.

Drift.—The departure of a projectile from the vertical plane in which it is fired. Drift is caused by the rotation of the projectile and the resistance of the air. In the United States service drift is always to the right.

Firing data.—All data necessary for firing a gun at a given objective.

Firing tables.—A collection of data, chiefly in tabular form, intended to furnish the ballistic information necessary for conducting the fire of a particular model of gun with specified ammunition.

Fuze.—A device attached to a projectile which controls the time of burst of the projectile.

Ground speed.—The linear velocity of the target, usually expressed in yards per second, with reference to the ground.

Gunner's quadrant.—An instrument used on the quadrant seat of a cannon to measure the vertical angle between the axis of the bore and the horizontal.

Horizontal range.—The length of the base of the vertical right triangle in space, the vertical side of which is altitude and the hypotenuse of which is the line of position.

Leveling.—The process of adjusting a gun and mount or an instrument so that all vertical or horizontal angles will be measured in true vertical or horizontal planes.

Line of position.—The line of position, or line of site, of a point is the straight line connecting the point of origin with that point. The point of origin is usually a gun or position-finding instrument.

Line of sight.—The line of vision; the optical axis of an observation instrument.

Line of site.—*See* Line of position.

Mil.—A unit of angular measure. One sixty-four-hundredth part of of a circle. For practical purposes the arc which subtends a mil at the center of a circle is equal in length to one one-thousandth of the radius.

Muzzle velocity.—The velocity of the projectile at the origin of the trajectory. Also called initial velocity.

Normal.—Geometrically the term means perpendicular to. When used in connection with reference scales, the normal setting is that reference scale setting which corresponds with a true setting of zero.

Orientation.—The establishment of true horizontal lines of known direction. The process of adjusting the azimuth circles of guns or instruments so that they will read correct azimuths when pointed in any direction.

Parallax.—The difference in azimuth or direction of a point as viewed from two other points.

Pintle center.—The vertical axis about which a gun and its carriage are traversed.

Plane of fire.—The vertical plane containing the axis of the bore when the gun is ready to fire.

Plane of position.—The vertical plane containing a line of position.

Pointing.—The operation of giving a piece a designated elevation and direction.

Position finding.—The process of determining the present and future positions of a target for the purpose of directing fire upon it.

Position of the target.—Two positions of the target are considered—

(1) *Present position* is the position of the target at the instant of firing.

(2) *Future position* is the predicted position of the target at the end of the predicted time of flight.

Predicting.—The process of determining the expected position of the target at some future time.

Quadrant elevation.—The vertical angle between the horizontal and the axis of the bore when the gun is pointed in elevation.

Reference numbers.—Arbitrary numbers used in place of actual values in the graduation of certain scales. Their purpose is to avoid the use of positive and negative values.

Round.—All of the component parts of ammunition necessary in the firing of one shot.

Sense.—The direction of a point of burst, center of burst, or center of a cone of fire, with respect to the target or other aiming point, as over or short, right or left, above or below.

Slant range.—The hypotenuse of the vertical right triangle in space, the vertical side of which is altitude and the base of which is horizontal range.

Spotting.—The process of determining the position of a point of burst or of the center of a cone of fire with respect to the adjusting point.

Superelevation.—That part of the quadrant elevation which allows for the curvature of the trajectory under the conditions actually existing.

Synchronization.—A process in which the values indicated by all receiver pointers of a data-transmission system are made to agree with the values set on the corresponding transmitters.

Symbols.—Letters used to represent certain elements of firing data, angles, or position of the target. For example: ϵ (epsilon) represents angular height; ϕ (phi), quadrant elevation; H, altitude; F, fuze range; and R, horizontal range.

Time of flight.—The elapsed time from the instant the projectile leaves the bore of the gun to the instant of impact (burst).

Trajectory.—The curve described by the center of gravity of a projectile in flight.

99. Antiaircraft guns.

Angular unit method.—A method of adjusting antiaircraft artillery gunfire in which range deviations in mils obtained by a flank observer are converted into altitude corrections in yards for application at the director.

Directing point.—A point in or near a battery for which the firing data are computed. If a gun of the battery is the directing point, it is called the *base piece* or *directing gun.*

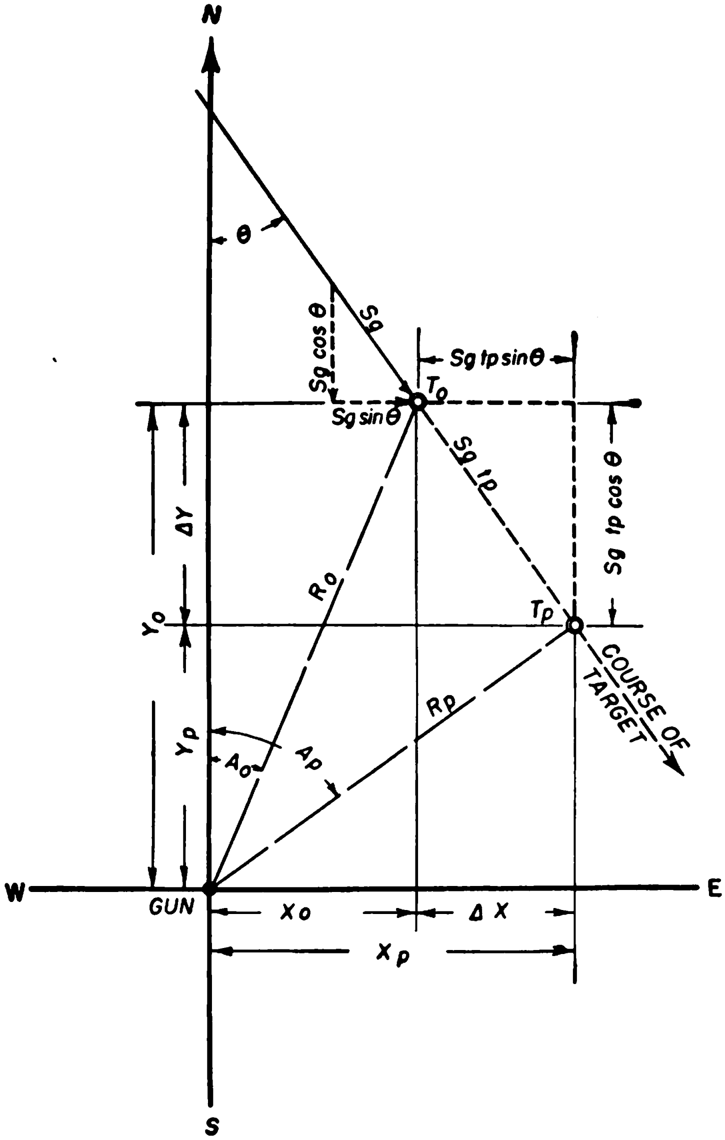
E–W and N–S rates.—The continuous tracking of the target establishes an instantaneous rate of speed (S_g.) relative to the ground. This rate is resolved into an east-west component (E–W rate) and north-south component (N–S rate).

E–W and N–S travel (ΔX and ΔY).—The E–W and N–S rates multiplied by time of flight give E–W and N–S travel during the time of flight of the projectile.

Fuze range.—The fuze setting necessary to cause the projectile to burst at a given point in space.

Gun difference.—The difference, due to displacement, between the range from a gun to the target and the range from the directing point to the target.

Trial fire.—Deliberate fire at a point in space to determine corrections for firing data. Normally five rounds are fired, all from the same gun.



A_o — Azimuth of target at present position (T_o).

A_p — Azimuth of target at future position (T_p).

ΔX or $S_g t_p \sin \theta$ — East-west component of travel of target during time of flight of projectile.

ΔY or $S_g t_p \cos \theta$ — North-south component of travel of tar get during time of flight of projectile.

R_o — Horizontal range to target at present position (T_o).

R_p — Horizontal range to target at future position (T_p).

S_g — Ground speed of target.

$S_g \cos \theta$ or N-S rate — North-south component of ground speed of target.

$S_g \sin \theta$ or E-W rate — Ease-west component of ground speed of target.

$S_g t_p$ — Linear travel of target in horizontal plane during time of flight.

θ — Angle between vertical planes containing course of target and north-south axis of director. (Never greater than 90°).

T_o — Position of target at instant of firing (present position).

T_p — Future or predicted position of target.

t_p — Time of flight to future position of target (T_p).

X_o — East-west component of horizontal range to present position (T_o).

X_p — East-west component of horizontal range to future position (T_p).

Y_o — North-south component of horizontal range to present position (T_o).

Y_p — North-south component of horizontal range to future position (T_p).

FIGURE 136.—Elements of data, linear speed method (horizontal projection).

Trial shot point.—A point in space at which trial fire is conducted.

X_o and Y_o.—The horizontal range to the present position of the target is resolved into components in east-west direction (X_o) and north-south direction (Y_o).

X_p and Y_p.—The horizontal range to the future (predicted) position of the target is resolved into components in the east-west direction (X_p) and north-south direction (Y_p).

100. Antiaircraft automatic weapons.—*Central control.*—A method of fire control for automatic weapons in which the leads are controlled from a central point rather than by the individual gunner.

Individual control.—A method of fire control for automatic weapons in which the leads are controlled by the individual gunner.

Initial lead.—A lateral or vertical lead applied to the gun sights before firing is commenced.

Lateral lead.—The angle in the slant plane of the lateral sight by which the gun must lead the target to cause the projectile and target to meet.

Vertical lead.—The angle by which the gun must lead the target vertically in order that the projectile will meet the target at the future position. It is measured in the vertical plane containing the axis of the bore of the gun.

101. Antiaircraft searchlights.—*Acoustic corrections.*—Corrections to sound locator data for nonstandard atmospheric conditions and sound lag.

Aerial sound ranging.—The process of locating aircraft by means of the sounds emitted.

Arbitrary corrections.—Corrections to sound locator data which are applied to correct for observed errors after all known deviating causes have been corrected for.

Distant electric control.—A system for the control of the pointing of searchlights from a distance. The system consists of the controller at the control station and the necessary motors or receivers at the searchlight.

Sound lag.—The angular difference between the actual (present) position of the target and the apparent position as indicated by sound.

Zero reader.—A device for indicating when the searchlight is properly pointed on corrected sound locator data.

Section III

PARTICULAR DEFINITIONS PERTAINING TO SUPPLIES AND SUPPLY FUNCTIONS

102. General.

Credit.—An allocation of a definite quantity of supplies which is placed at the disposal of the commander of an organization for a prescribed period of time.

Distributing point.—A place, other than a depot or railhead, where supplies are issued to regiments and smaller units. Distributing points are designated by the class of supplies therein, and by the identity of the unit establishing them, such as "Class I Distributing Point, 1st Division," or "Ammunition Distributing Point, 1st Infantry."

Dump.—A temporary stockage of supplies established by a corps, division, or smaller unit. When supplies are ordered issued from dumps, the latter become distributing points. Dumps are designated by the identity of the unit establishing them and by the class of supplies therein, such as "1st Infantry Ammunition Dump" or "1st Division Class I Supply Dump."

Railhead.—A supply point on a railroad where loads are transferred from rail transportation to some other type of transportation. Railheads are designated in the same manner as distributing points; for example: "Class I Railhead, 1st Division," or "Ammunition Railhead, 1st and 2d Divisions."

Requisitions.—Requests for supplies, normally submitted on the prescribed form, to a higher commander. When approved by the higher commander, a requisition becomes an order for issue of supplies by the proper supply agency to the supply officer of the unit which submitted the requisition.

Shipping ticket.—A form which accompanies a shipment of supplies to a supply officer and which he must sign and return to the shipping officer to accomplish transfer of accountability.

Supply point.—A general term used to include depots, railheads, dumps, and distributing points.

Train.—That portion of a unit's transportation, including personnel, operating under the immediate orders of the unit commander primarily for supply, evacuation, and maintenance. It is designated by the name of the unit; such as "1st Infantry Train."

103. Supplies other than ammunition.

Automatic supply.—A process of supply under which deliveries of specific kinds and quantities of supplies are moved in accordance with a predetermined schedule. *Daily automatic supply* means that supplies are dispatched daily to an organization or installation.

Classes of supplies.—There are five classes of supplies.

Class I.—A class of supplies consisting of those articles which are consumed at an approximately uniform daily rate irrespective of combat operations or terrain, and which do not necessitate special adaptation to meet individual requirements; such as rations and forage.

Class II.—A class of supplies consisting of those authorized articles for which allowances are established by Tables of Basic Allowances; such as clothing, gas masks, arms, trucks, radio sets, tools, and instruments.

Class III.—A class of supplies consisting of engine fuels and lubricants, including gasoline for all vehicles and aircraft, Diesel oil, fuel oil, and coal.

Class IV.—A class of supplies consisting of those articles which are not covered in Tables of Basic Allowances and the demands for which are directly related to the operations contemplated or in progress (except for articles in classes III and V); such as fortification materials, construction materials, and machinery.

Class V.—A class of supplies consisting of ammunition, pyrotechnics, antitank mines, and chemicals.

Forage.—Food for animals. To collect supplies for men and animals.

Issue.—A delivery of supplies. Specifically, the delivery of supplies of any kind by a supply department to responsible persons authorized to receive them on behalf of their organizations. Also the supplies so delivered.

Memorandum receipt.—A receipt given to a supply officer by a person drawing supplies from him, or a receipt given by the supply officer to a person returning supplies to him.

Railhead distribution.—Issue of class I supplies to regimental (or similar unit) transportation at the railhead.

Ration.—The prescribed allowance of the different articles of food for the subsistence of one person or one animal for one day.

CHAPTER 11

COMMUNICATION

SECTION I

USE AND CARE OF FIELD TELEPHONES

104. Sending, receiving, and recording messages.—*Q.* For best results, where should the telephone transmitter be placed with respect to the mouth? *A.* Not more than one inch from the mouth but not touching it.

Q. How should words be pronounced over the telephone? *A.* Use a moderate tone of voice. Speak slowly and distinctly without slurring any words or syllables. Avoid using words which are difficult to pronounce or with meanings not generally known. When necessary to repeat, make the pronunciation more distinct but never shout or raise the pitch of the voice.

Q. How are numerals sent? *A.* Singly. Thus 4,370 is sent "four, three, seven, zero." Zero is never pronounced "Oh." A numeral involving a decimal, like 246.34, is sent thus: "two, four, six, point, three, four." An exact hundred such as 200, is sent: "two hundred"; 4,500, "four five hundred." Even thousands are sent in the same manner, for example, 4,000 is "four thousand."

Q. What is the procedure when the receiver repeats the message back to the sender? *A.* Listen carefully to the message. If any part of the message is incorrectly repeated, call "error" and repeat that portion of the message. When the message has been correctly repeated back to the sender, the sender should call "check."

Q. What is the procedure if the sender discovers that he has incorrectly sent part of a message? *A.* He immediately calls "error" and

identifies the portion of the message in error. He then gives the correct message. With short messages it is best for the sender to repeat the entire message.

Q. How are numerals pronounced? *A.*

Numeral	Spoken as—	Principal sounds
0	ZE-RO	Long O.
1	WUN	Strong W and N.
2	TOO	Strong T and long OO.
3	THUH-R-EE	Slightly rolling R and long EE.
4	FO-WER	Long O, strong W and final R.
5	FI-YIV	I changing from long to short and long V.
6	SIKS	Strong S and KS.
7	SEV-VEN	Strong S and V, and well-sounded EN.
8	ATE	Long A and strong T.
9	NI-YEN	Strong N, long I, and well-sounded YEN.

Q. What is meant by the "phonetic alphabet"? *A.* Certain letters of the alphabet have similar sounds and are often confused in telephone conversations. To avoid this difficulty the following pronunciation of letters over the telephone is prescribed:

Letter	Spoken as—	Letter	Spoken as—	Letter	Spoken as—
A	Affirm.	J	Jig.	S	Sail.
B	Baker.	K	King.	T	Tare.
C	Cast.	L	Love.	U	Unit.
D	Dog.	M	Mike.	V	Victor.
E	Easy.	N	Negat.	W	William.
F	Fox.	O	Option.	X	X-ray.
G	George.	P	Prep.	Y	Yoke.
H	Hypo.	Q	Queen.	Z	Zed.
I	Inter.	R	Roger.		

The words of the phonetic alphabet are used in place of the letters they represent just as in spelling a word. Expressions such as "A as in Affirm" or "A for Affirm" are not used. For example, in transmitting the words BARTS CHURCH the word BARTS is apt to be misunderstood. The phonetic spelling is as follows: "BARTS, Baker-Affirm-Roger-Tare-Sail." The phonetic alphabet is also used in the transmission by telephone of coded messages. For example, the code group XISV is transmitted as "Xray-Inter-Sail-Victor."

Q. Give some pointers which will increase the efficiency of receiving messages. *A.*

(1) Keep the mind on the message; a person cannot receive correctly when he is thinking of something else.

(2) Keep the receiver close against the ear.

(3) Do not interrupt the sender except in cases where not to do so would be of serious disadvantage to the correct reception of the message.

(4) Repeat all messages received. Where messages are long, repeat each sentence as it is sent. When any part of a message is not understood, call "Repeat," and continue to have the message transmitted until it is understood.

Q. How is the telephone answered when it rings? *A*. First: Give the official designation or name of the station. Second: Give the official designation of the person answering.

Q. What is a flash message? *A*. A message used to indicate the approach of aerial targets. The indication of the target is preceded by the word FLASH, repeated three times, and the report is given twice without waiting for an acknowledgment.

Q. Do flash messages follow a particular form? *A*. Yes, they must follow a form and no unnecessary words should be used.

Q. What information is contained in a flash message? *A*.

(Front)

FORM FOR FLASH MESSAGE

(AAAIS)

Organization____________________

Serial No.____________ Date____________________ How sent________________

Time sent____________ To____________________

Observation post 1	Number of airplanes 2	Type of airplanes 3	Time seen or heard 4	Altitude 5	Sector in which flying 6	Direction of flight 7
	One______	Heavy bombardment	______	Very low___	______	North.
	Two_____	Observation________	______	Low_______	______	NE.
	Three____	Pursuit____________	______	Medium____	______	East.
	_________	Light bombardment_	______	High_______	______	SE.
OP___	Several___	Airplane___________	______	____________	______	{South. SW.
	Many____	__________________	______	____________	______	{West. NW.

NOTE.—Very low—below 500 yards; low—500 to 2,000 yards; medium—2,000 to 4,000 yards; high—above 4,000 yards.

Both sender and receiver check off items where possible and save time.

Q. How are altitudes classified? *A*. High—Above 4,000 yards; medium—2,000 to 4,000 yards; low—500 to 2,000 yards; very low—below 500 yards.

Q. What record is made of a flash message? *A*. The sender of the message, the operators who transmit it, and the units which receive it, usually record the message by checking the proper words and filling any appropriate blank spaces on a message form.

105. Laying wire, making connections, and tests.—*Q*. What common types of wire are used in field installations? *A*. Two types, both twisted pair, type W-110 and W-110B.

Q. Describe each type. *A*. Type W-110 wire has rubber compound insulation covered with weatherproof braid. There are 7 strands, 5 steel and 2 copper. Its weight is 132 pounds to the mile. Resistance is 130 ohms per mile.

Type W-110B is similar to W-110 but has 4 steel and 3 copper strands. Its weight is 132 pounds to the mile. Resistance is 95 ohms per mile. (The candidate should be able to identify either type of wire by looking at it. Arrange a pile of short pieces of different types of wire and let the candidate make his own selection.)

Q. What means are provided for laying wire? *A*. The wire is carried or laid by any one of the following means, depending upon the conditions of the roads, terrain, and traffic, and character of hostile fire: Motor trucks; especially constructed horse- and motor-drawn carts and reels; reel carts, hand-drawn or towed behind communication carts; breast reels; spools or coils carried by hand. If issued on wooden spools, wire may be laid by inserting an iron bar through the spool and paying off from it, or the wire may be rewound onto a spool of special design provided for the purpose.

Q. What is the present standard reel? *A*. The reel unit RL-31.

Q. Describe the reel unit, type RL-31. *A*. It is a portable wire-laying and recovery device. It may be used in any one of several ways, as follows:

(1) Carried litter fashion between two men.

(2) Pushed or dragged along the ground by one man, wheelbarrow fashion, the reel rims acting as wheels.

(3) Mounted inside or on the extended tail gate of any vehicle which provides the required space. Foot fittings are provided for mounting.

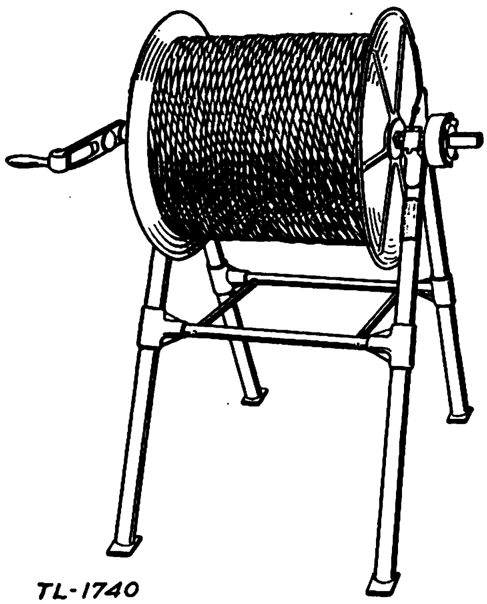
(4) Set up on the ground for unreeling or reeling in the wire.

(5) Mounted outside any vehicle by attachment to the outside of the tail gate.

The unit has a removable brake which may be mounted to either end of the axle. Wire is reeled in by means of a crank which may be placed on the end of the axle.

Q. What is the capacity of the reel unit RL-31? *A*. One 1-mile reel (type DR-5) or one or two ½-mile reels (type DR-4) of wire type W-110 or W-110B.

Q. In laying wire should the lines be pulled as tightly as possible or laid loosely? *A*. The lines should be laid loosely in order that the wire may lie flat on the ground, and so as to provide sufficient slack for repairing breaks. At suitable intervals lines should be attached to objects such as trees or posts in order to leave sufficient slack, and to prevent the wire from being pulled into traffic lanes.



TL-1740

FIGURE 137.—Reel unit RL-31 with reel DR-5.

Q. How should a traffic lane be crossed in laying wire? *A*. Where possible the lines should cross roads through the culverts. The wires are passed through the culvert and tied up at the entrance and exit to prevent immersion in the water. When it is necessary to carry the wires overhead they should clear the crown of the road by 14 feet. When a line crosses a road between poles or other vertical supports, the wires should be tied at the base and top of the support on each side of the road. The strain which occurs along the line is met by the tie at the base. If neither of the above methods can be used, the line wires should be buried in a trench, crossing the road at right angles. The wires must be laid snug and well secured at both ends of the trench to prevent their being pulled out.

Q. In laying the wire at what intervals should it be tested? *A.* It should be tested just after making each splice, through the splice, when laying wire in the field. In the case of wire on a reel a test should be made before the reel is taken out of storage.

Q. Given two pieces of field wire, describe and illustrate how to make a standard field wire splice. *A.* To obtain a uniform stagger in making the splice, measure back one plier's length (about 6 inches) from the end of one conductor and cut it at this point. Cut one wire of the other pair in the same manner. Crush the insulation on each conductor, starting at about 6 inches from the end and extending back to 2 inches from the end. Use the heel of the pliers for crushing. Score or ring the crushed insulation, at a point about ½ inch from where the crushing began, with the cutting edge of pliers. Using the pliers, skin the crushed insulation off each conductor, being careful not to damage the strands. Clean the strands with the back of the screw driver blade of the electrician's knife. Now tie the long and short conductors together, using a square knot so that the knot occurs about ¼ inch from the insulation. Strip the weatherproof braid from the insulation about ½ inch on each side of the knot. Insert a 6 to 8 inch piece of 19 gage bare copper seizing wire in the knot and pull the knot tight. Bend the seizing wire at the middle and make 2 or 3 turns on either side of the knot to bind the ends of the knot. Cut the free ends of the conductors flush with end of insulation. Wrap the seizing wire to left and right of the knot until 2 turns are taken over the insulation. Cut off the excess wire and press ends of seizing wire into the insulation. Apply two layers of rubber tape followed by two layers of friction tape.

Q. When joints cannot be taped, what should be done to prevent short circuits and grounds? *A.* The joints should be staggered and raised off the ground.

Q. What are some of the troubles which may occur in a telephone system, and what are the tests and remedies? *A.* See table at end of this paragraph.

Q. Describe and demonstrate how to test a telephone. *A.* Install the battery. Holding the receiver to the ear, blow steadily into the transmitter while alternately operating and releasing the handset switch. The blowing should be very audible as long as the handset switch is at the "on" position. Holding the receiver to the ear, operate the generator. The handle should be easy to turn and the impulses should be heard in the receiver. The ringer should not

operate. Short circuit L_1 and L_2 and turn the generator again. It should now be hard to turn as though a drag had been placed on it, the impulses should be heard in the receiver, and the ringer should not operate. Remove the short.

Connect the telephone to another telephone known to be serviceable. Turn the generator on the other telephone. The ringer of the telephone being tested should operate.

Q. What repairs are telephone operators authorized to make? *A*. With the exception of changing batteries, cleaning contacts which are accessible without taking down the telephone, and changing the headset or handset, the operator is not authorized to make any repairs.

Q. How can most telephone troubles be avoided? *A*. Most of the troubles in telephone communication can be avoided if telephones are carefully used and cared for and are examined and tested before being taken out for service each day. In addition, the batteries must be in good condition, and care must be taken to see that all joints make good contact, including all splices in the lines.

Trouble	Possible cause	Tests and remedies
Home station cannot ring distant station.	(1) Improper line connection at telephone.	(1) Examine connections. Clean and tighten if necessary.
	(2) Open circuit in line.	(2) Examine line for breaks.
	(3) Generator out of order.	(3) Test the telephone at the home station. Repair or replace as may be necessary.
	(4) Receiving circuit open or damaged receiver.	(4) Test the telephone at the distant station. Repair or replace as may be necessary.
	(5) Ringer at the distant station not functioning.	(5) Test the telephone at the distant station. Repair or replace as may be necessary.
	(6) Short circuit in line.	(6) A shorted line is usually distinguished by the generator turning hard. Examine the connections and the line. Remove the short when discovered.
Distant station cannot ring home station.	See above	See above.

Trouble	Possible cause	Tests and remedies
Home station can signal distant station but cannot hear distant station talk.	(1) Operator at distant station not operating the hand set switch.	(1) Operate the hand set switch properly.
	(2) Battery at the distant station dead.	(2) Test the battery. If weak or exhausted, replace.
	(3) Battery contacts corroded.	(3) Examine contacts and battery terminals. Clean if necessary.
	(4) Broken transmitter cord at distant station.	(4) Disconnect handset and touch battery terminals with receiver and transmitter cords, being sure that the hand set switch is operated at the same time. A click should be heard in the receiver if the transmitter cord is all right. Replace cord if necessary.
	(5) Hand set switch at distant station does not make contact.	(5) Test as in (4) above. Clean and adjust if necessary.
	(6) Carbon in transmitter at distant station packed.	(6) Usually distinguishable by sizzling or crackling noise in receiver. Replace telephone.
	(7) Broken receiver cord at home station.	(7) Disconnect handset. Touch receiver and common cords to terminals of a battery simultaneously. If a click is heard the receiver circuit is all right. Replace cord if necessary.
Distant station can signal home station but cannot hear home station talk.	See above__________	See above.
Station cannot signal switchboard.	(1) Fuse on switchboard burned out (BD-9, BD-11 only).	(1) Examine fuses and replace if necessary.
	(2) Shutter stuck on its hinge.	(2) Trip shutter by hand. If the shutter will not drop of its own accord, clean hinge.
	(3) Armature holding shutter is out of adjustment or bent.	(3) BD-9 or BD-11: Hold tip of red (operator's) plug against terminals of section being tested. Ring operator's telephone. If the armature vibrates but does not release the shutter, adjust armature until it does.

Trouble	Possible cause	Tests and remedies
		BD-71 or BD-72: Put the plug of an unused circuit across the terminals of the unit being tested. Put ring-talk key to ring position and operate the generator. If the armature vibrates but does not release the shutter, adjust armature until it does.
	(4) Coil of shutter release magnet burned out.	(4) Test as in (3) above. If the armature does not vibrate, the coil is probably burned out. Replace entire unit.
Night bell fails to operate when a shutter drops.	(1) Battery dead	(1) Test battery and replace if necessary.
	(2) Loose or dirty connections.	(2) Check through all connections. Clean and tighten where necessary.
	(3) Bell contacts corroded.	(3) Examine bell. Clean the contacts if necessary.
	(4) Shutter dropping does not close bell circuit.	(4) Adjust the contacts so the circuit will be completed.
	(5) Bell coils open	(5) Connect a receiver in series with a battery and the bel coils. When the circuit is closed there should be a click in the receiver if coils are all right. Replace if necessary.

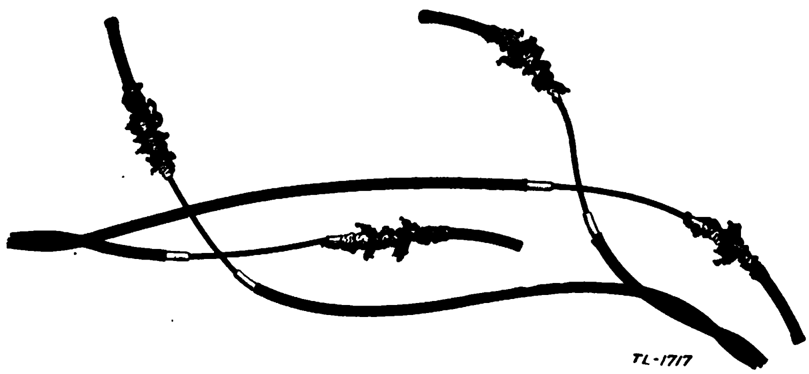


FIGURE 138.—Wires skinned and ready for square knots.

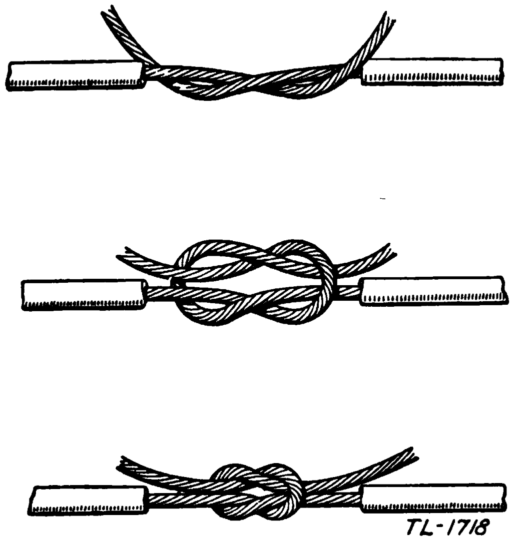


FIGURE 139.—Tying square knot.

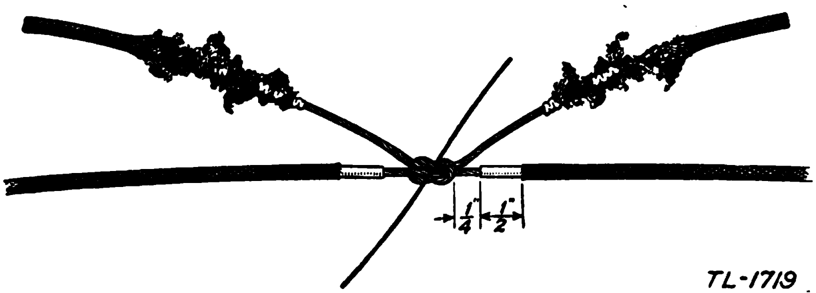


FIGURE 140.—Seizing wire inserted through knot.

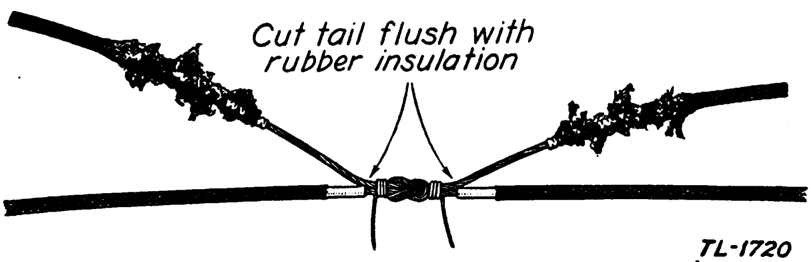


FIGURE 141.—Wrapping seizing wire.

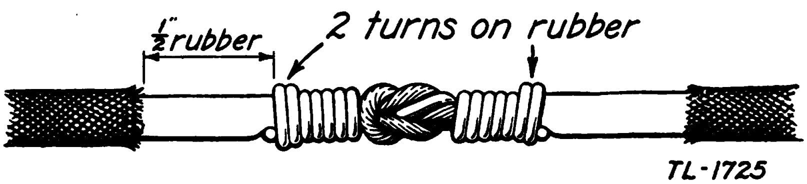


FIGURE 142.—Splice on one conductor after seizing is completed.

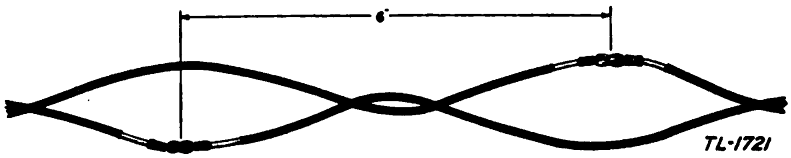


FIGURE 143.—Splice ready for taping.

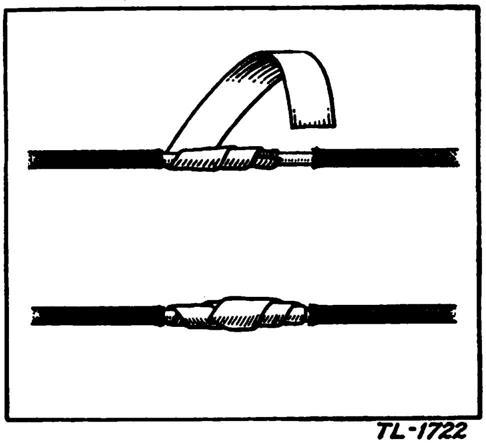


FIGURE 144.—Applying rubber tape.

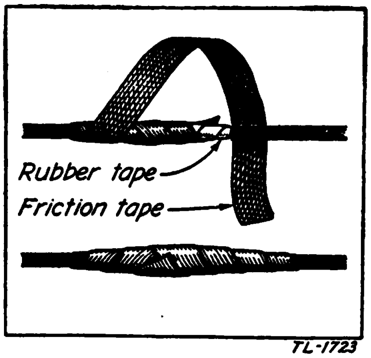


FIGURE 145.—Applying friction tape.

106. Telephone apparatus.—*Q*. What telephones are furnished for field use? *A*. Signal Corps field telephones EE-5, EE-8, and EE-8A.

Q. Are these telephones classified as local or common battery types? *A*.

(1) EE-8. Either local or common battery.

(2) EE-8A. Either local or common battery.

(3) EE-5. Local battery only.

Q. Name the principal circuits of a local battery telephone. *A*.

(1) The primary circuit, which consists of the transmitter, battery and primary winding of the induction coil.

(2) The secondary circuit, which consists of the receiver, condenser, and secondary winding of the induction coil.

(3) The signaling circuit, which consists of the generator and ringer. These circuits are basic in all local battery telephones. Certain telephones, such as the EE–8 and EE–8A, will have additional circuits, but in any case these additional circuits supplement the above basic circuits.

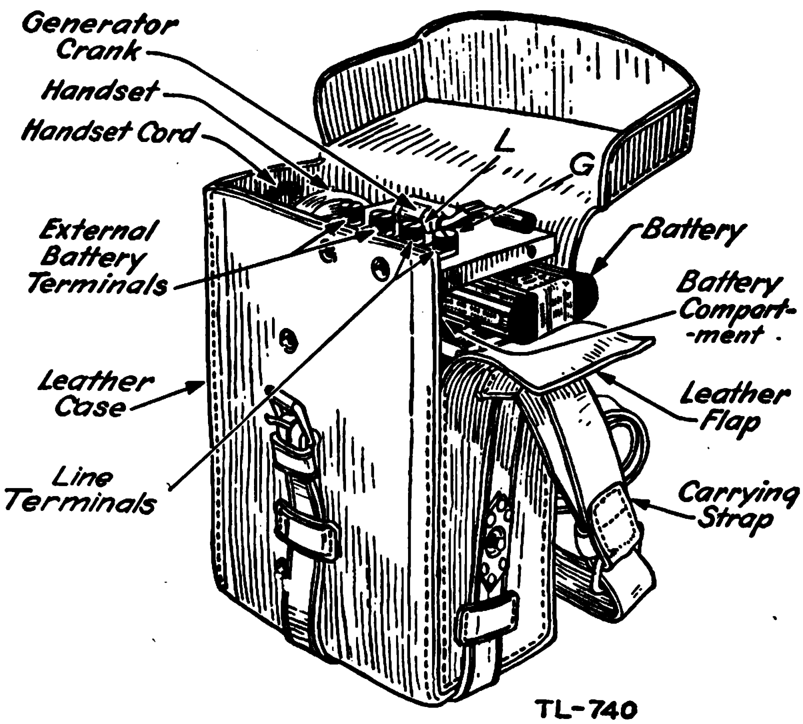


FIGURE 146.—Field telephone, type EE–5.

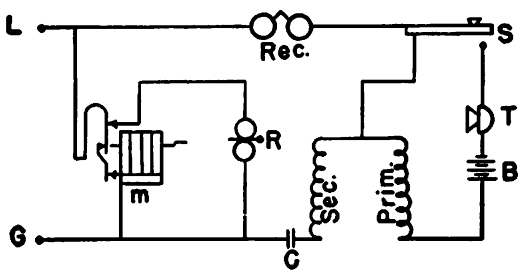


FIGURE 147.—Circuit diagram, type EE–5 telephone (modified).

Q. How is the signaling circuit connected? *A*. The circuits of both the generator and the ringer are bridged in parallel across the line terminals.

Q. Does the battery current flow through the signaling circuit? *A*. No. The circuit through the generator is always open except when the crank is turned. A condenser in the ringer circuit prevents the battery current from flowing through the ringer.

Q. Does the current from the generator flow through the receiver and transmitter? *A*. The handset switch must be operated in order to complete the circuit through the transmitter. Hence the generator current will not ordinarily flow through the transmitter. The receiver is always connected across the line, so that generator current could flow through it. However the resistance of the receiver circuit to low frequency currents is very high. The generator produces alternating current at 20 cycles or less per second. Hence very little of the generator current will go through the receiver circuit.

Q. How are the batteries installed in the EE–8 and EE–8A telephones? *A*. Remove the handset from the carrying compartment. Place two batteries BA–30 in the battery compartment (fig. 148), being sure that the bottoms of the batteries rest on the springs and that the tops of the batteries rest against the contacts at the top of the compartment.

Q. How is the battery installed in the EE–5 telephone? *A*. One battery BA–9 (4½ volts) is inserted in a spring clip just below the top of the frame (fig. 146). The battery is covered by the leather flap formed by one side of the case. Two screws which hold this flap to the frame must be removed to insert the battery, after which the screws should be replaced.

Q. How is the station opened when using an EE–8 or EE–8A telephone? *A*. Open the case and remove the handset from the carrying compartment. Place the batteries in the battery compartment. Connect the ends of the line to the terminals marked L1 and L2. With a screw driver turn the screw switch to the proper position, depending on whether the telephone is to be operated by local battery or by common battery. There are about 1½ turns of the screw switch between the local battery and common battery positions. If using local battery, call the switchboard, using the generator. If using common battery, removal of the handset from its position on the lever switch will call the switchboard. Report the designation of the station and request a ring back. If using common battery, it will be necessary to replace the handset on the lever switch before the switchboard can ring back.

Q. How is the station opened when using an EE–5 telephone? *A*. Open the cover of the telephone. Remove the crank from the clamp on top and screw it on the magneto shaft which extends out of the side of the case. Remove the handset from the carrying compartment. Connect the ends of the line to the terminals marked "L" and "G." Call the switchboard by turning the crank. Report the designation of the station and request a ringback.

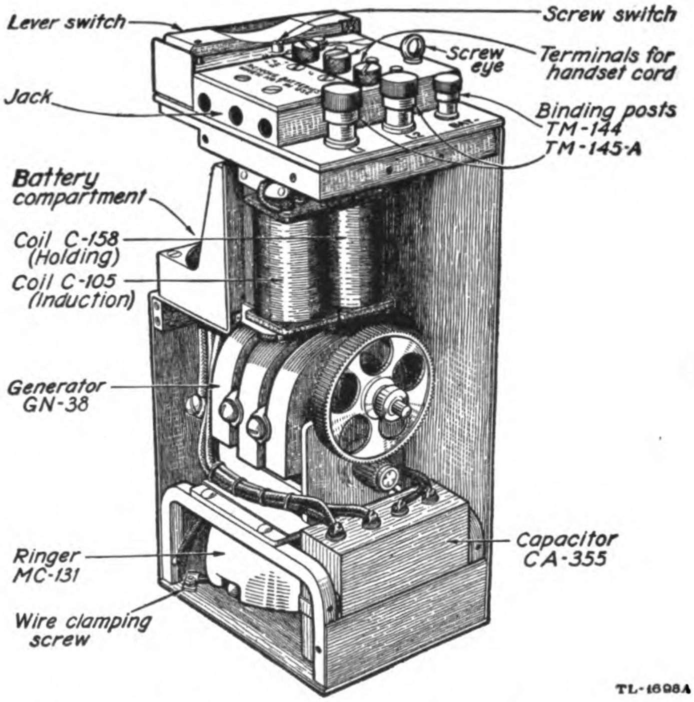


FIGURE 148.—Field telephone, type EE-8, with side plates removed.

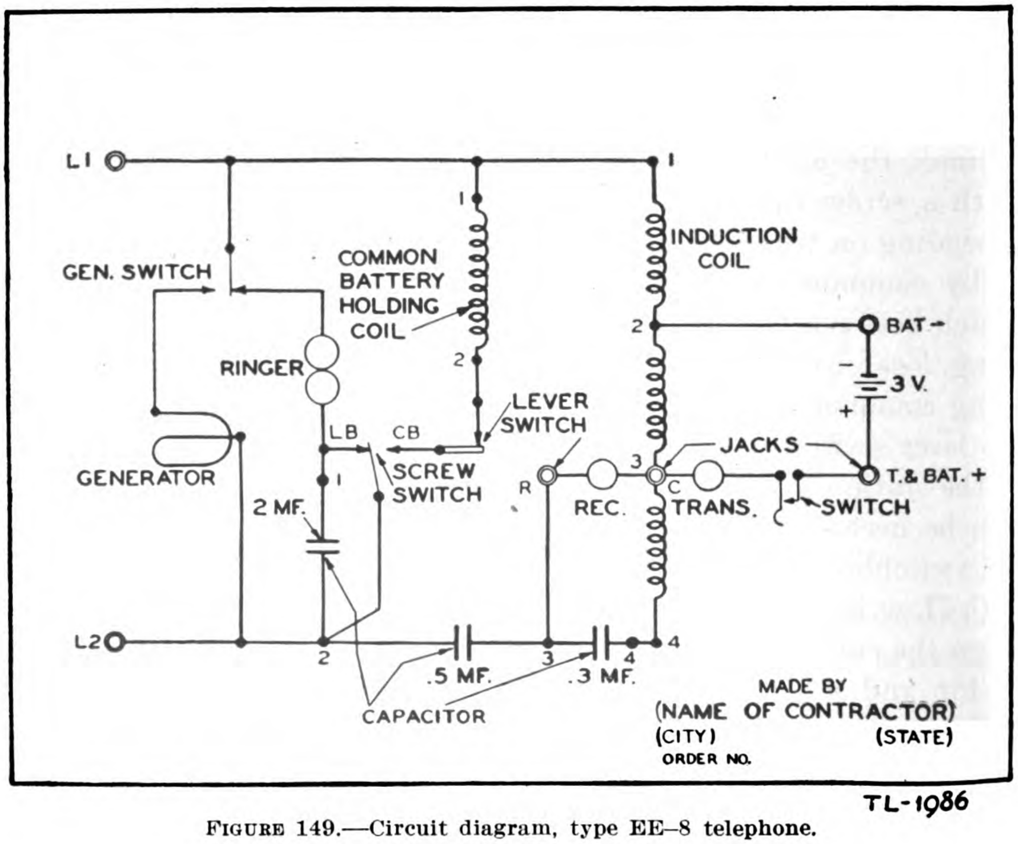


FIGURE 149.—Circuit diagram, type EE-8 telephone.

Q. How is the station closed? *A.* Report the fact of closing to the switchboard. Disconnect the line from the terminals. With the EE–5 remove the crank and place it in its carrying position. If the telephone is not going to be used again *immediately*, remove the battery or batteries.

Wrap the cord about the handset and replace the handset in the carrying compartment.

If the batteries were left in the telephone, be sure that the cord does not operate the handset switch.

Q. Demonstrate hooking up two telephones to a length of wire and establish communication. (Local battery only.) *A.* (Practical demonstration proved by actual communication.)

Q. Is it necessary to operate the handset switch in order to listen? *A.* No, and furthermore the operation of the handset switch when listening only is bad practice as it exhausts the battery rapidly.

Q. How may the battery in a local battery telephone be tested? *A.* If the battery terminals are touched to the tongue, there should be a salty taste noted. Another test is to blow lightly into the transmitter while holding the transmitter switch closed. A distinct sound should be heard in the receiver. In this test, the line should be disconnected from the telephone.

Q. When should a telephone be tested? *A.* Always before it is taken out for service. Thereafter the tests are made periodically as prescribed. The fact that circuits are in constant use is indicative that they are operating satisfactorily. A telephone which is ordinarily very busy and which suddenly becomes quiet should be tested at earliest opportunity. Communication should never be interrupted to make a routine test.

107. Field switchboard apparatus.—*Q.* Name the different types of field switchboards. *A.* BD–14, BD–71, BD–72, BD9, and BD–11. All types except the BD–14 are monocord switchboards.

Q. Describe the BD–71 and BD–72 switchboards. *A.* The switchboard is inclosed in a plywood case mounted on four collapsible steel legs. The unit includes switchboard units, cords, operator's telephone with head and chest sets, lights, switches and night alarm, batteries BA–30, repeating coils, and terminal strips. Outside of the fact that the BD–71 has only 6-line capacity compared to the 12-line capacity of the BD–72, there is no practical difference between the two switchboards.

Q. Describe the BD–9 and BD–11 switchboards. *A.* The BD–9 has a capacity of 4 lines and the BD–11 of 12 lines. The unit consists of a frame on which the individual drops are mounted.

Operator's telephone, terminal strips, repeating coils, and similar items are all separate from the switchboard. A fiber carrying case is provided for the protection of the switchboard when not in use.

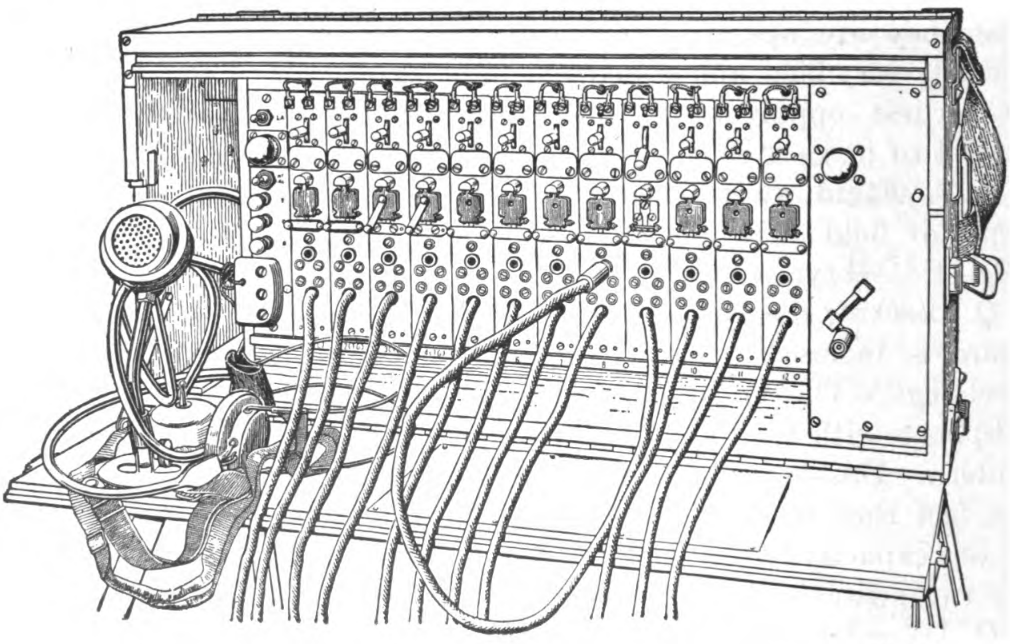
Q. Demonstrate hooking up a telephone, a length of wire, and a BD–71 or BD–72 switchboard. *A*. (Practical demonstration proved by actual functioning.)

Q. Demonstrate hooking up an operator's telephone, battery, night alarm, and one line with telephone connected to a BD–9 or BD–11 switchboard. *A*. (Practical demonstration proved by actual functioning.)

Q. What is the purpose of the ground wire? *A*. Protection against lightning. An air spark gap is incorporated in each unit. The ground wire grounds one side of the lightning arrester.

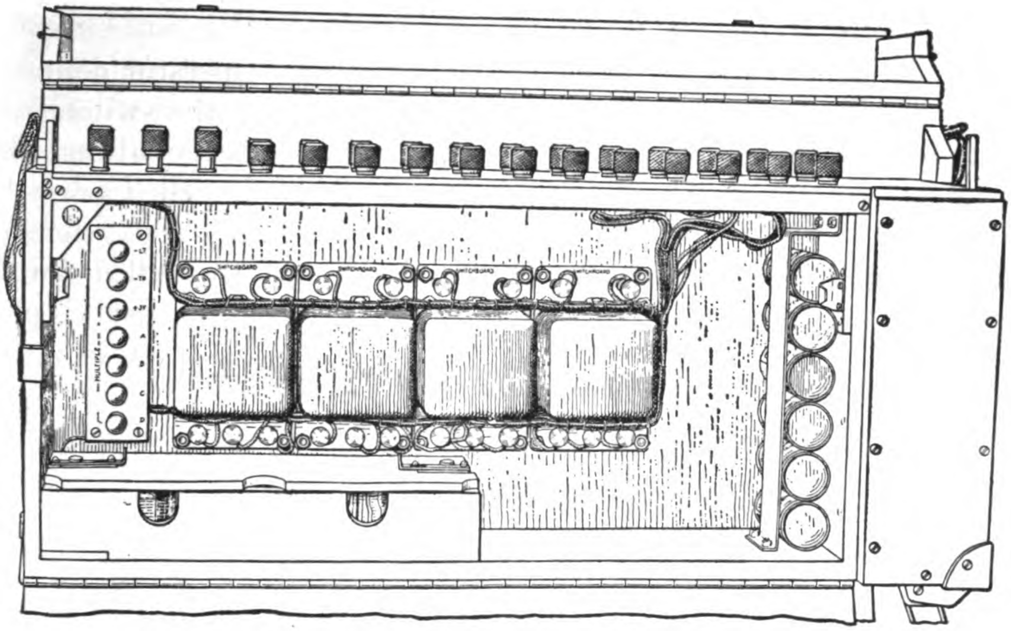
Q. Is it desirable for the operator to keep his telephone connected to two lines which are in use? *A*. No. The extra load which his telephone puts on the lines will impair transmission between the two telephones which are in use.

Q. How does the switchboard operator know when someone is calling the switchboard? *A*. Ringing current on the calling line operates the shutter coil and allows the shutter to drop to the horizontal position. If the night alarm switch is closed, the shutter cam will close the night alarm circuit and cause the alarm to operate as long as the shutter is down.



SCL–3

FIGURE 150.—BD–72 switchboard, front view, open.



SCL-4

FIGURE 151.—BD–72 switchboard, rear view, open.

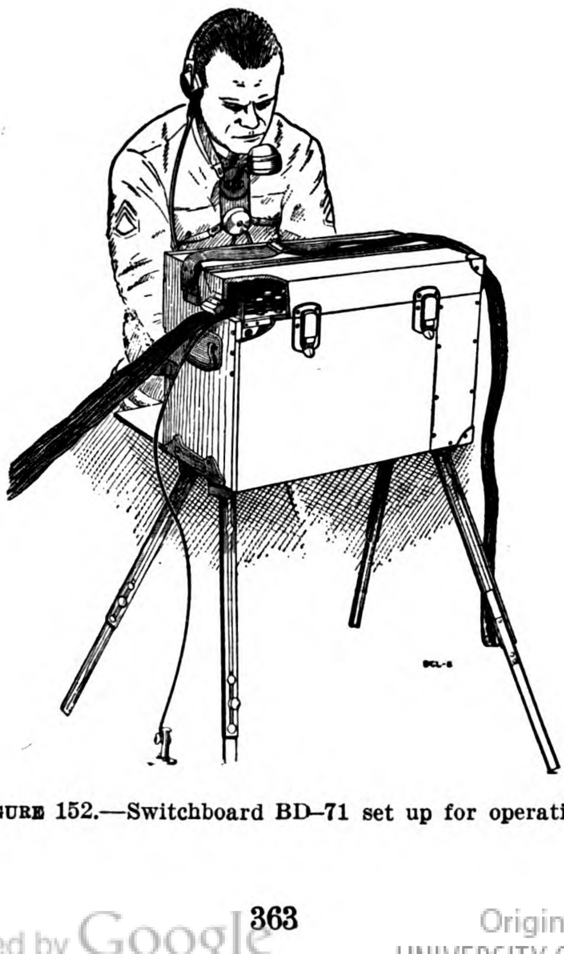


FIGURE 152.—Switchboard BD–71 set up for operation.

Q. What does the operator do when he sees the shutter drop on one of the units? *A.*

(1) *If using a BD–71 or BD–72 switchboard.*—Operator depresses the ring-talk key on the unit calling. He identifies the switchboard by name and determines the number desired by the party calling. He then restores the calling party's key and rings the called party by raising the ring-talk key on that unit and turning the generator handle rapidly several times. He next depresses the called party's ring-talk key to the talk position and inserts the calling party's plug in the jack of the called party. While the ring-talk key is in the talk position, the operator's telephone is bridged across the connection, allowing him to supervise the call. The calling party's shutter is left in the dropped position until the call has been completed. A shutter down indicates that the call has not been completed and that further supervision of the connection is necessary.

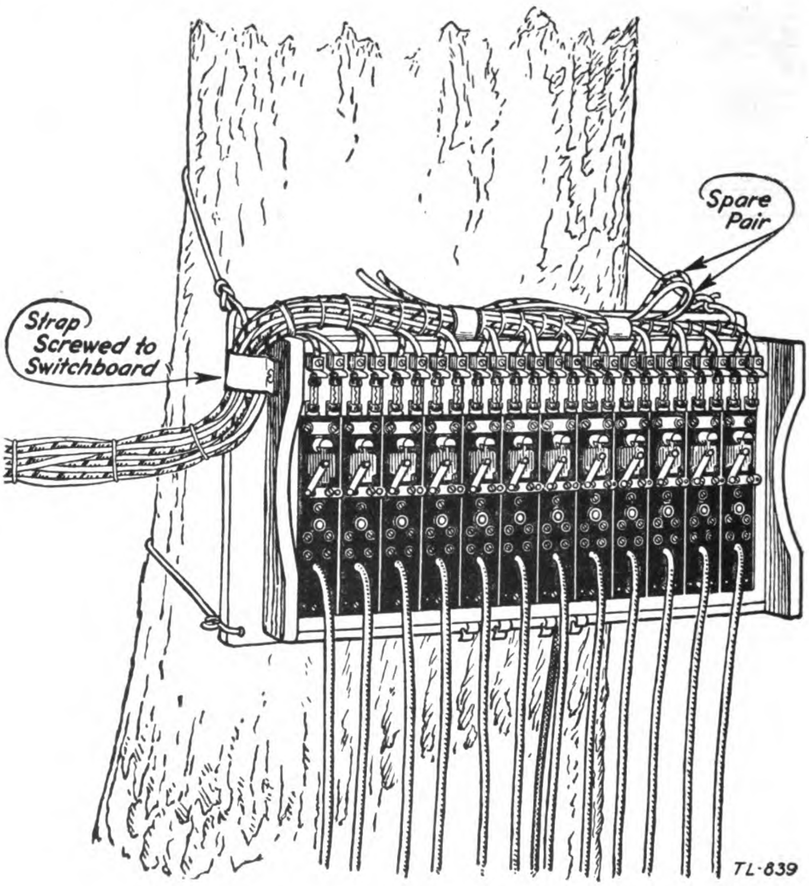


FIGURE 153.—Switchboard BD–11.

(2) *If using the BD–9 or BD–11 switchboard.*—Operator inserts his plug in the calling party's jack, identifies the switchboard by name, and determines the number desired by the calling party. He

places the operator's plug in the jack of the called party and turns the generator of the operator's telephone. He then inserts the called party's plug in the jack of the calling party. The operator leaves his plug in the jack until he finishes supervising the call at which time he removes his plug and restores the shutter on the calling party's unit.

Q. Why must the switchboard be upright when in operation? *A*. The shutter drops by gravity. If the board is not upright or inclined slightly forward, the shutter cannot drop.

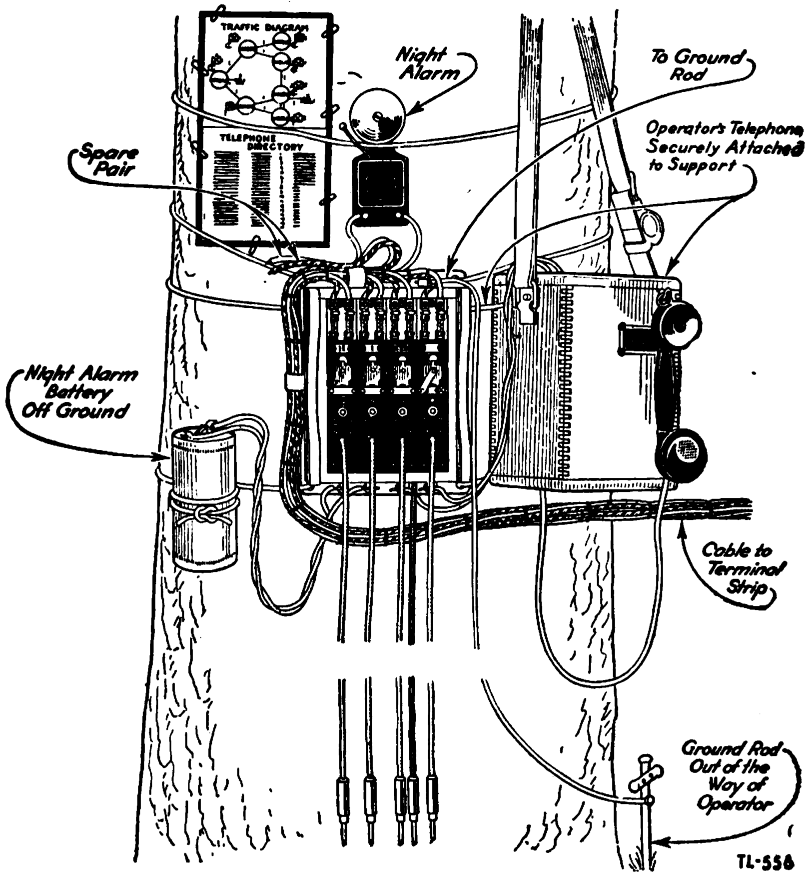


FIGURE 154.—Switchboard BD-9 set up for operation.

SECTION II

USE AND CARE OF TELEPHONES FOR FIXED ARTILLERY

108. Use.—The use of the telephone in fixed seacoast artillery is identical with that prescribed for the field telephone in paragraphs 104 and 105.

109. Care.—*Q.* What type of telephone is used in fixed installations? *A.* The common battery artillery type.

Q. What are the two classes of telephone "sets" in artillery work, and how are they used? *A.* "Auxiliary sets" and "talking sets," so arranged that any of the talking sets can be used with any auxiliary set to make up a complete telephone. The auxiliary set contains all the local parts of the telephone proper, except the receiver and transmitter. The talking sets are the receiver and transmitter made up in different forms for different kinds of service.

Q. What is the latest type of telephone used in plotting rooms? *A.* Wall telephone, type EE-71. (See fig. 155.)

Q. Name the different auxiliary sets. *A.* Of the common battery type: Wall set; plotter's set; battery commander's set; portable set; and gun set.

Q. Name the different talking sets. *A.* The head set, hand set, and desk set.

Q. What kind of head set is in general use with common battery telephones? *A.* The head set, type EE-70.

Q. What are the latest designs of head and chest sets, and hand sets? *A.*

(1) The latest design of head and chest set is the HS-17-A.

(2) The latest design of hand set is the HS-9.

Q. What are the important characteristics of each *A.*

(1) The head and chest set (HS-17-A) is designed for use with telephone box (EE-91) and connection should not be made to any circuit permitting direct current to flow through the receiver windings.

(2) The design of the hand set (HS-9) is similar to that of the head and chest set (HS-17-A). The circuit restrictions are the same.

Q. What care should be given head sets? *A.* The receiver should never be dropped or hammered. The transmitter should be kept dry and handled carefully. If the carbon packs in the transmitter, the case may be tapped gently to loosen the carbon.

Q. What supplies the energy to operate the telephone? *A.* A central storage battery located in the switchboard room.

Q. Point out the induction coil. What is its function? *A.* The induction coil induces an alternating current in the hearing circuit in unison with the fluctuations in the talking circuit current.

Q. Point out the hook switch. What is its use? *A.* It breaks the local circuit when the telephone is not in use (receiver on hook

or retaining spring attached), thus preventing the storage battery from running down.

Q. Point out the condenser. What is its function? *A*. It prevents the direct current from the storage battery from flowing through the bell and the generator. It also makes the talking more distinct.

Q. Point out the generator. What is its function? *A*. When the generator crank is turned, the armature is revolved and an alternating current is generated which rings the bells.

Q. Point out the terminal posts for the head set. How can you tell which wire should be attached to each post? *A*. The wires are of different colors and the terminal posts are labeled with the corresponding colors.

Q. Tell how to open station. *A*.

(1) Take the head set or retaining spring off the hook and put on the head set.

(2) See that the connections are tight. These include the two connections to the line and three for the head set.

(3) Lower and raise the hook. A sharp click should be heard. A slight scratching in the transmitter should be heard in the receiver.

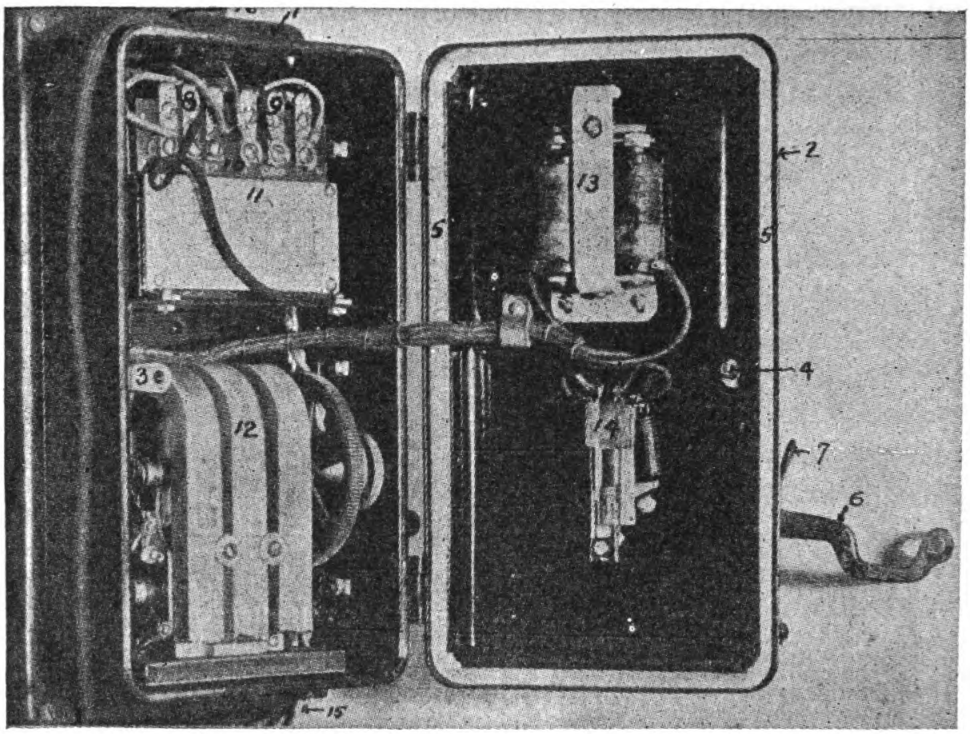
(4) Call the name of the distant station.

(5) To ring up the distant station, hold the hook down and turn the generator handle. (Some C. B. telephones are modified so that they will ring with the hook up.) Release the handle to talk. If any hooks on the line are up, none of the distant bells will ring.

Q. How can you tell when there is no power on the line? *A*. No tap is heard on the bell or click in the receiver when the hook is operated, and no shock is felt if the line terminals are touched with moistened fingers.

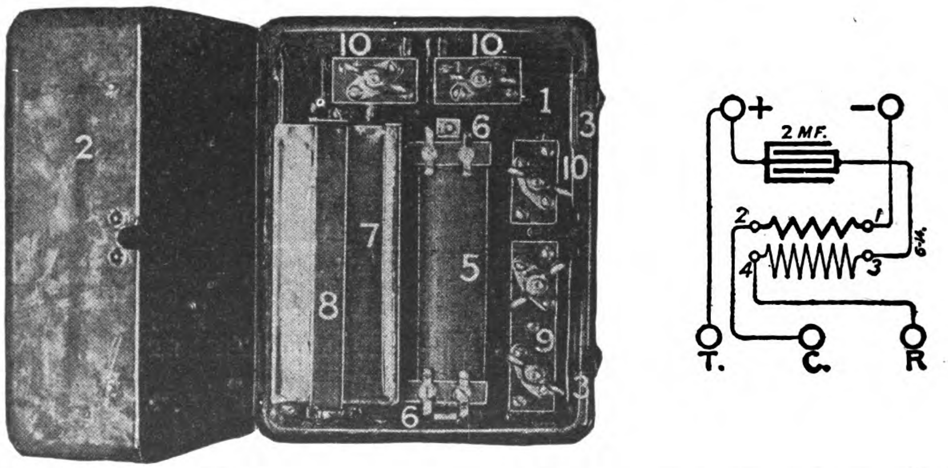
Q. How is the station closed? *A*. Hang the receiver on hook or attach the retaining spring.

Q. What care should be taken of the telephone? *A*. Never leave the station with the hook up; keep the nuts on the terminal posts tight and the cords clear of tangles; keep the door shut. Report trouble immediately to the noncommissioned officer in charge. Do not attempt to repair anything inside the case.



1. Metal case.
2. Door for metal case.
3. Screw fastener, internally threaded.
4. Wing bolt for fastening door.
5. Rubber gasket.
6. Hook.
7. Hook retainer.
8. Line contacts.
9. Talking set contacts.
10. Induction coil behind terminal strip.
11. Condenser behind wiring diagram.
12. Generator.
13. Ringer.
14. Hook switch.
15. Line leads.
16. Talking set leads.

FIGURE 155.—Common battery telephone, type EE-71.



1, 2. Metal case and door.
3. Spring clip for door.
5, 6. Induction coil and terminals.
7. Condenser.
8. Strap for condenser.
9, 10. Rubber blocks with wing nut binding posts. (The numbers shown on the circuit diagram are for induction coil connections.)

FIGURE 156.—Plotters set and circuit, type EE-74.

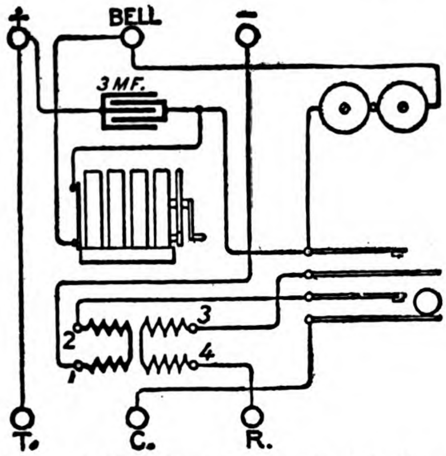
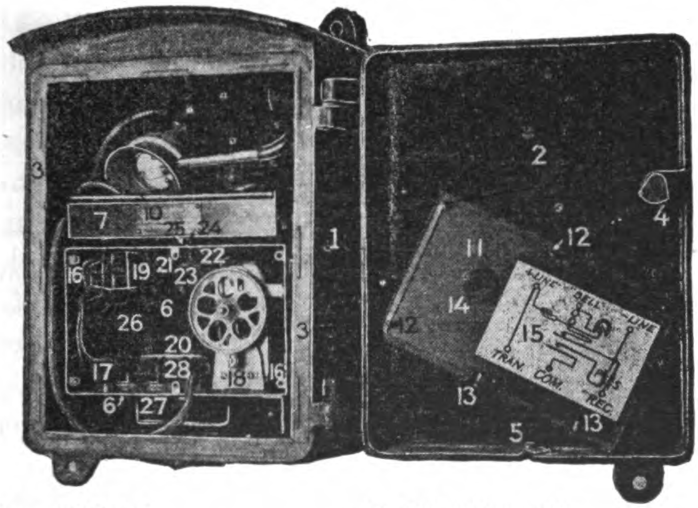
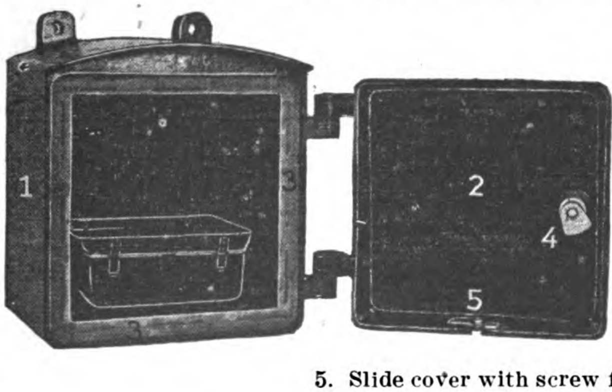


FIGURE 157.—Circuit of wall telephone.



1, 2, 4. Case, door and latch.
6. Inner case with contents and tray.
7. Tray base.
11. Cover for inner case.
13. Reinforcing plate for cord entrance.
14. Pushing plate for generator handle.
15. Circuit plate.
17. Induction coil.
18. Generator, 5-bar.
19. Condenser, 3 m.f.
20. Ringer.
21, 26. Tray switch.
27, 28. Rubber blocks with wing nut binding posts for line and talking sets.

FIGURE 158.—Battery commanders telephone, type EE-73.



1. Cast iron case.
2. Door.
3. Gasket.
4. Door handle and catch.
5. Slide cover with screw for cord slot. (The circuit of this telephone is identical with plotters set (EE-74).)

FIGURE 159.—Gun telephone, type EE-75.

Section III

INSTALLATION AND OPERATION OF HARBOR DEFENSE TELEPHONE SYSTEM AND NET

110. General.—*Q*. Is there a standard system for signal communication for fixed defenses? *A*. Yes.

Q. Are the systems in all harbor defenses alike? *A*. No. They all vary slightly from the standard system, to meet local conditions.

Q. Of what does the harbor defense telephone system consist? *A*. The fire-control telephone system and the post telephone system.

Q. What does the fire-control telephone system include? *A*. Telephone lines necessary for the tactical direction and control of fire.

Q. How are these lines laid and connected? *A*. These lines are laid in lead cables with various numbers of pairs in each cable, usually 10, 20, 50, or 100 pairs, depending on the need, and a permanent connection is maintained. However, the pairs from the various cables lead into the fire-control switchboard where changes in connection may be made.

Q. Are there usually spare pairs in the cable connecting various points? *A*. Yes.

Q. Are post telephone lines usually laid in cables? *A*. Yes.

Q. What is the difference between the fire-control telephone system and the post telephone system? *A*. The fire-control telephone system makes a permanent connection between various stations so that when you turn the magneto crank on a fire-control phone you ring a certain telephone or group of telephones. In the nonautomatic post telephone system when you lift your receiver you call the switchboard operator who connects you to your desired telephone. In the automatic post telephone system any telephone in the system may be connected automatically with any other telephone in the system by proper operation of the dial attached to the calling telephone.

Q. Of what types are fire-control telephone and post telephone systems? *A*. Common battery types.

111. Fire-control telephone system.—*Q*. Where are fire-control telephones placed? *A*. Wherever they are needed for the control of fire, conduct of fire, and transmission of data.

Q. If you desire to change a connection between fire-control telephones does a switchboard operator do it? *A*. No. The electrician sergeant in charge of the fire-control switchboard is notified and he makes the desired new connections on the switchboard.

Q. Describe the fire-control system in use in this harbor defense. *A*. ———.

Q. What are the more important items of equipment in the fire-control switchboard room? *A*.

(1) The telephone power switchboard and distributing frame or the telephone switchboard.

(2) The telephone storage battery.

(3) The motor-generator.

(4) The time-interval apparatus.

Q. What are the functions of the telephone power switchboard? *A*. This switchboard provides means for—

(1) Charging the telephone storage battery by the motor-generator set.

(2) Connecting the telephone storage battery to the telephone system through retardation coils or repeating coils.

(3) Connecting the telephone storage battery to the signal circuit for operating the motor of the time-interval apparatus.

(4) Connecting the motor-generator to the signal circuit and motor of the time-interval apparatus.

(5) Connecting the motor-generator to the telephone system.

(6) Any combination of the above connections.

(7) Reading the voltage and current of the storage battery or the motor-generator set and testing for grounds on the telephone and signal circuits.

(8) Starting, stopping, and regulating the output of the motor-generator.

Q. Describe the telephone storage battery. *A*. It is the normal means employed to energize the fire-control system. It consists of fifteen cells of the lead-acid type, usually contained in glass jars, and furnishes the 30-volt direct current necessary for the operation of the telephone system.

Q. What are the functions of the motor-generator? *A*. It operates from the power supply system and generates current at from 25 to 50 volts pressure. It is used to—

(1) Charge the storage battery.

(2) Ring the various time-interval and other signal bells throughout the fire-control system.

(3) Energize the telephone system directly in an emergency.

Q. What is the distributing frame? *A*. It is a frame mounting a number of terminal strips. All cables, both telephone and time-interval, are terminated on these terminal strips. Any desired hook-up of the system may be made by cross-connections, called "jumpers," between the proper terminals on the terminal strips.

Q. What is the standard fire-control switchboard? *A*. The present standard fire-control switchboard is the type BD–74, which with the type BD–75 distributing frame replaces all previous switchboards used in fire-control telephone systems. It provides an extremely flexible system. (See fig. 161.)

Q. Describe briefly the BD–74 switchboard. *A*.

(1) All permanent cross-connections for the fire-control telephone system are made either on the line terminal strips or the cross-connecting terminal strip in rear of the board.

(2) Repeating coils are substituted for retardation coils and provide for the application of battery voltage to the telephone and prevent battery voltage being applied to the line connecting two telephones.

(3) Where a telephone is connected to another telephone by means of a permanent cross-connection or by means of patching cords, signaling is accomplished by ringing the magnetos of the individual telephones without the intervention of an operator.

(4) In addition to the permanent connections, the terminals of the line to each telephone in the system are brought to a unit of four jacks on the front of the switchboard.

(5) These jacks are arranged in a vertical row, marked from top to bottom, "Line," "Swbd," "Tie," and "Tie C. O."

Q. How are temporary changes in the permanent connections made? *A*. By use of "patching cords" (cords having a plug on each end) which are plugged into the proper jacks on the front of the switchboard.

Q. What is the purpose of the "Line" jack? *A*. This jack, when plugged, will disconnect the line from the switchboard and permit a test of the line only. (See fig. 162.)

Q. What is the purpose of the "Swbd" jack? *A*. This jack, when plugged, permits test of battery power and the "wet" side of the repeating coil. (See fig. 162.)

Q. What is the purpose of the "Tie" jack? *A*. This jack, when plugged, permits answering a call from the telephone on that unit in the switchboard room without cutting out the telephone to which

it is permanently connected or to "tie" the telephone on that unit to another net to which it is not permanently connected. (See fig. 162.)

Q. What is the purpose of the "Tie cut-off" jack? *A*. This jack, when plugged, cuts its telephone off from its permanent connection and permits it connection by "patch cord" to another telephone not permanently connected to it. This jack is used for temporary hook-ups. (See fig. 162.)

Q. How is it possible to know which telephones are in use? *A*. By observing the supervisory lamps on the front of the switchboard. These lamps light up when the hook-switch of the telephone is up.

112. **Time-interval apparatus.**—*Q*. What does the time-interval apparatus do? *A*. It accurately indicates intervals of time by means of bells for use in firing the guns and operating the position-finding systems.

Q. What are the major parts of the time-interval apparatus? *A*.

(1) Four control disks.

(2) Driving motor. Operates on 30 volts at a speed of 1,280 rpm.

(3) Fly-ball governor for varying the speed of rotation of the motor.

(4) Four contactors, one for each circuit.

(5) Terminals for each circuit.

(6) Notched metal blocks mounted on each control disk.

Q. How many revolutions per minute do the control disks make? *A*. They make one revolution per minute.

Q. How many points do the notched blocks have? *A*. Each block has from one to three saw-toothed points, each point causing the bells of the circuit on which it operates to ring once.

Q. How is the desired time interval produced by any one control disk? *A*. By varying the number, points, and spacing of the notched blocks on the control disk. (See fig. 163.)

Q. When a block has more than one point, what is the interval of time between points of that block? *A*. The points are separated by 6° of arc which will give impulses at 1-second intervals.

Q. What are the normal time intervals for which the four control disks are bored? *A*. For 10, 15, 20, and 30 seconds. This will provide combinations on each disk to produce the desired interval.

Q. What is the purpose of the time-interval panel? *A*. It is a part of the time-interval system equipment. It provides a means of ringing the time-interval bells of any particular bell circuit at any one of the intervals provided by the control disk.

113. Post telephone system.—*Q*. Where are post telephones placed? *A*. In headquarters, barracks, quarters, artillery batteries, and various important stations.

Q. What characteristics should the ideal switchboard operator have? *A*. He is courteous, intelligent, efficient, and capable of working for long periods under stress. He is familiar with army organization. He speaks distinctly and is readily able to understand speech over the telephone.

Q. What is the meaning and use of the phrase "Number please"? *A*. It is used by an operator to answer a call on his switchboard.

Q. What is the meaning and use of the phrase "Thank you"? *A*. It is used by an operator to indicate that he has correctly understood a number given to him either by a local party or by an operator of another central and that he is proceeding to complete the call.

Q. What is the meaning of the phrase "What number please"? *A*. It is used by an operator to request repetition of a number which he has not understood.

Q. What is the meaning and use of the phrase "The line is busy"? *A*. It is used by an operator to report that a local telephone for which he has received a call is already in use.

Q. What is the meaning and use of the phrase " —— does not answer"? *A*. It is used by an operator in reporting that a certain local telephone or another central does not answer.

Q. What is the meaning and use of the phrase "Here's your party?" *A*. It is used by an operator whenever it is necessary for him to start the conversation over a connection.

Q. What is the meaning and use of the word "Waiting"? *A*. It is used as a challenge by an operator when supervising a connection and no conversation is heard.

Q. What is the meaning and use of the phrase "I will ring again"? *A*. It is used by an operator when, in supervising a connection, he is informed that the called party did not answer.

Q. What is the meaning and use of the phrase "What number is calling"? *A*. It is used by an operator, if after supervising a connection, he is given a new number to call by one of the parties.

Q. What is the meaning and use of the phrase "What number were you calling please"? *A*. It is used by an operator to determine the number desired by a party who reports that he has been given a wrong number or has been cut off.

Q. What is the meaning and use of the phrase "One moment please" or "I have a call for you"? *A*. They are used by an operator, if

necessary, to hold either party on the line while a new connection is being completed.

Q. Where may additional information on operating procedure be found? *A*. In FM 24-5.

Q. When using a manual switchboard, how does the operator know that a party is calling? *A*. When a party calls, a line light goes on.

Q. Describe the method of making a connection on a manual switchboard. *A*. When a party calls and the line light goes on, the operator takes the rear plug of any cord circuit pair of plugs and inserts it in the jack associated with the line light. The line light then goes out. The operator closes the ringing and listening key of the cord circuit used and finds out the number desired. He inserts the front plug in the jack of the called party's line, and moves the ringing and listening key to the ringing position for an instant, and then releases it.

Q. How does the operator know when the called party answers? *A*. The front supervisory light of the cord circuit used goes out.

Q. How does the operator know when the called party hangs up? *A*. The front supervisory lamp lights up.

Q. What provision is made for arousing the operator at night? *A*. A night alarm bell is installed on the switchboard and can be cut in by means of a switch so that it will ring when any line light goes on.

Q. When using an automatic system, is it necessary to make any connections between parties calling on the post? *A*. No.

Q. Why is it then necessary to have a switchboard operator on duty at all times? *A*. Connection of calls from off the post or to persons off the post must be made by the operator at the switchboard.

Q. If a party reports a telephone out of order, what should be done? *A*. Report the trouble to the wire chief at once.

NOTE.—The candidate should be required to demonstrate his ability to operate the harbor defense switchboard installed at the post.

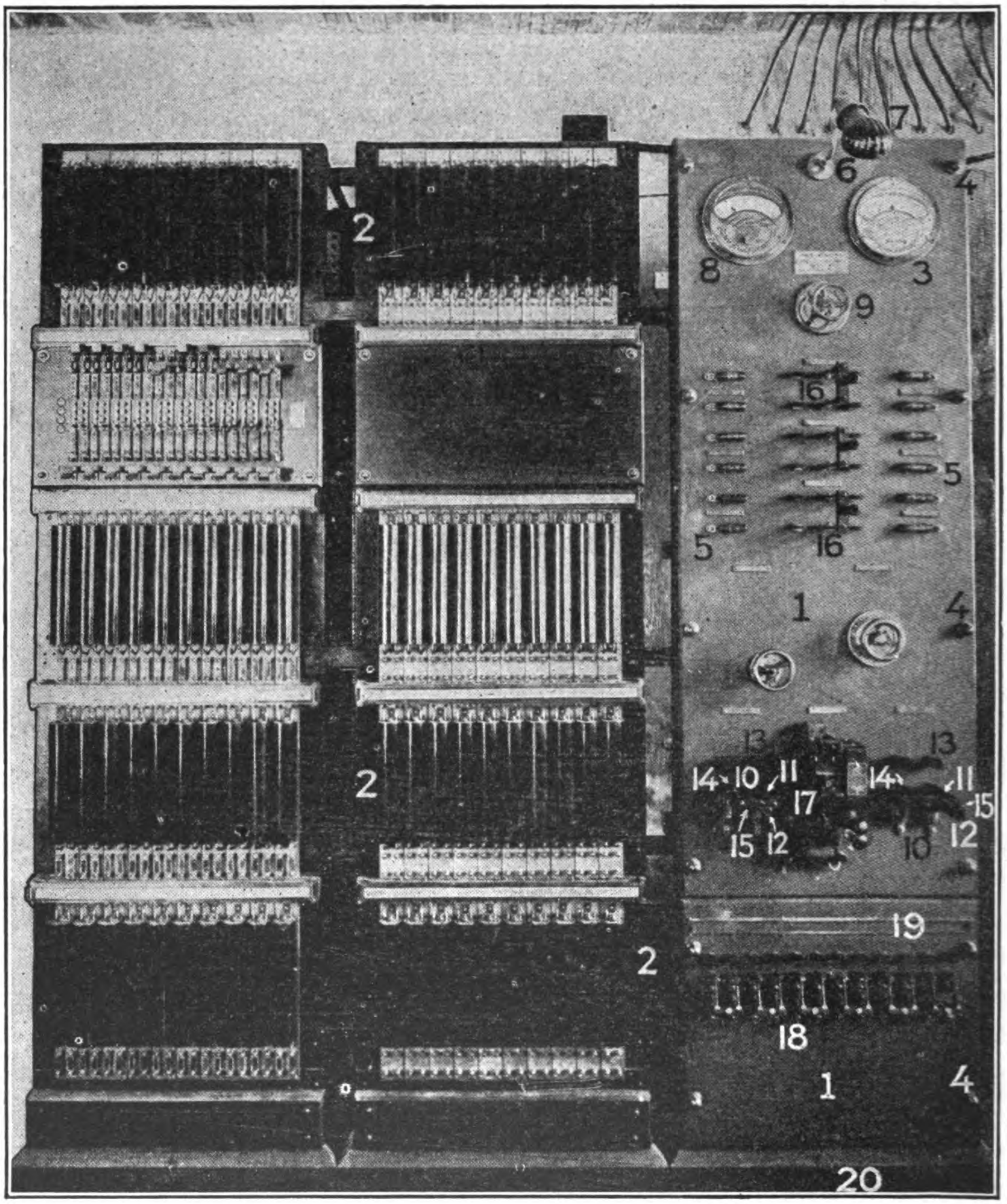


FIGURE 160.—Telephone power (fire-control) switchboard and distributing frame, old standard.

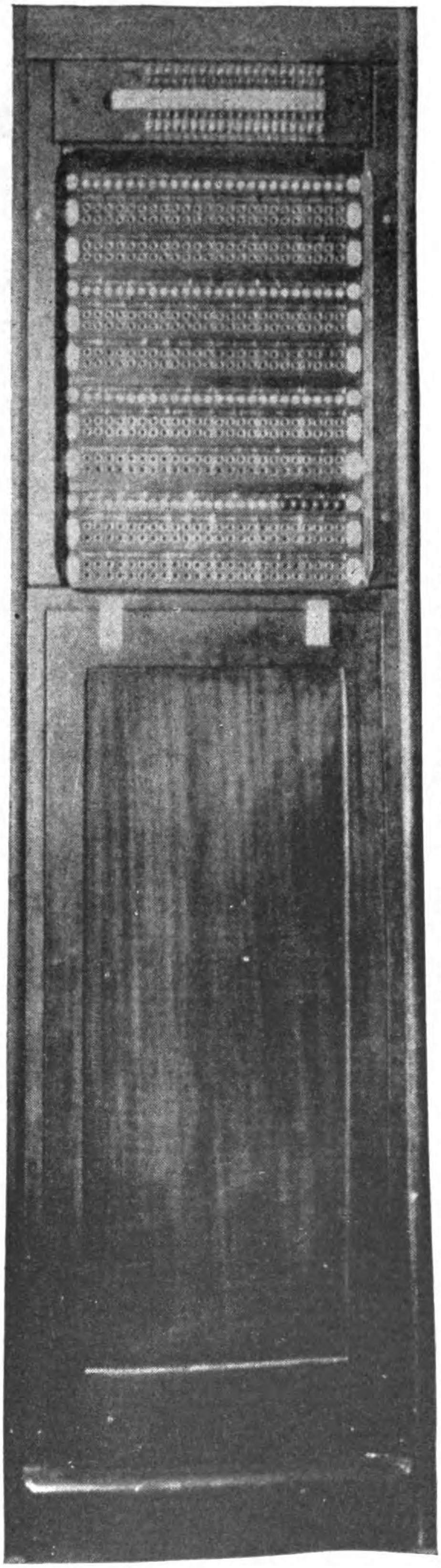


FIGURE 161.—Swithchboard, type BD–74.

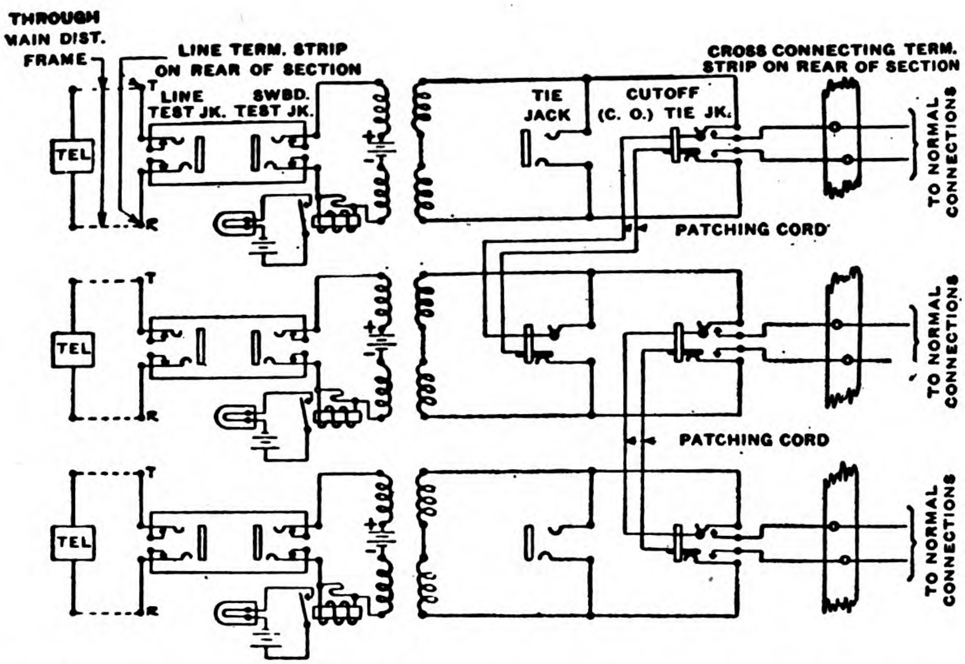


FIGURE 162.—Three units of the BD–74 switchboard. (Circuit showing three telephones with normal connections replaced with temporary connections by means of patching cords.)

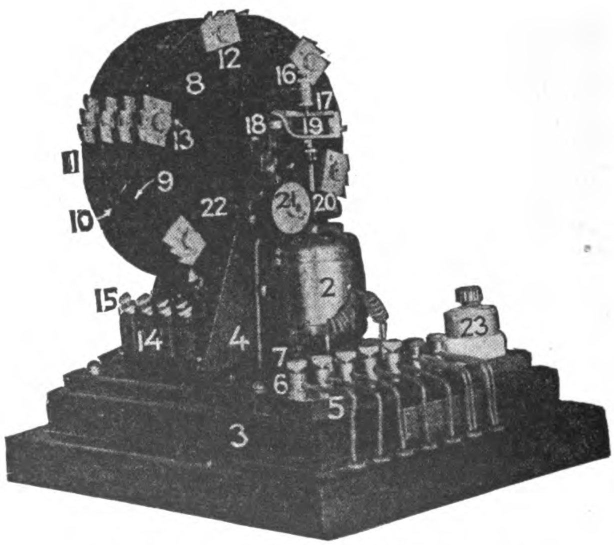


FIGURE 163.—Time-interval apparatus.

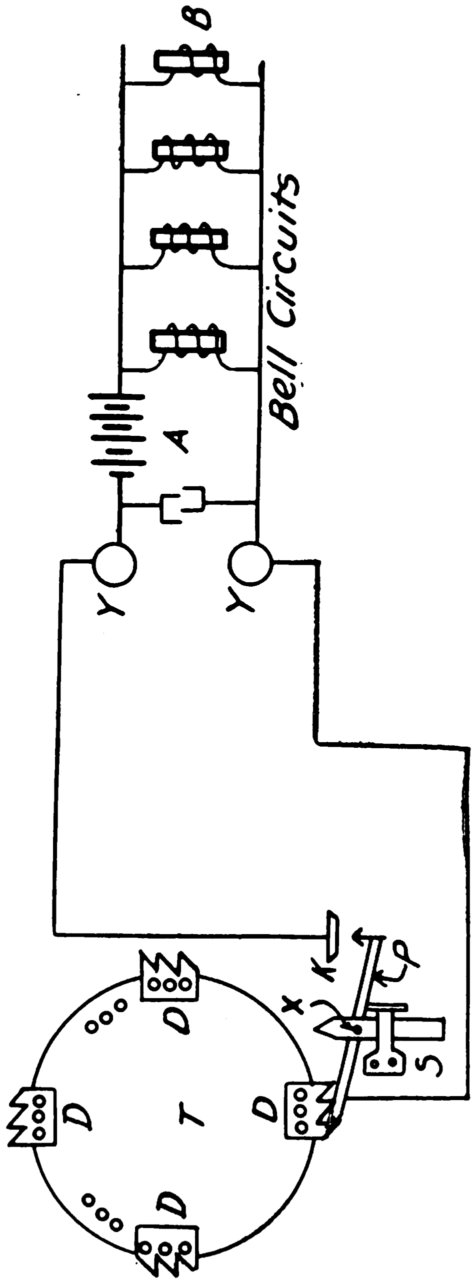


FIGURE 164.—Schematic diagram of the bell circuit of the time-interval system.

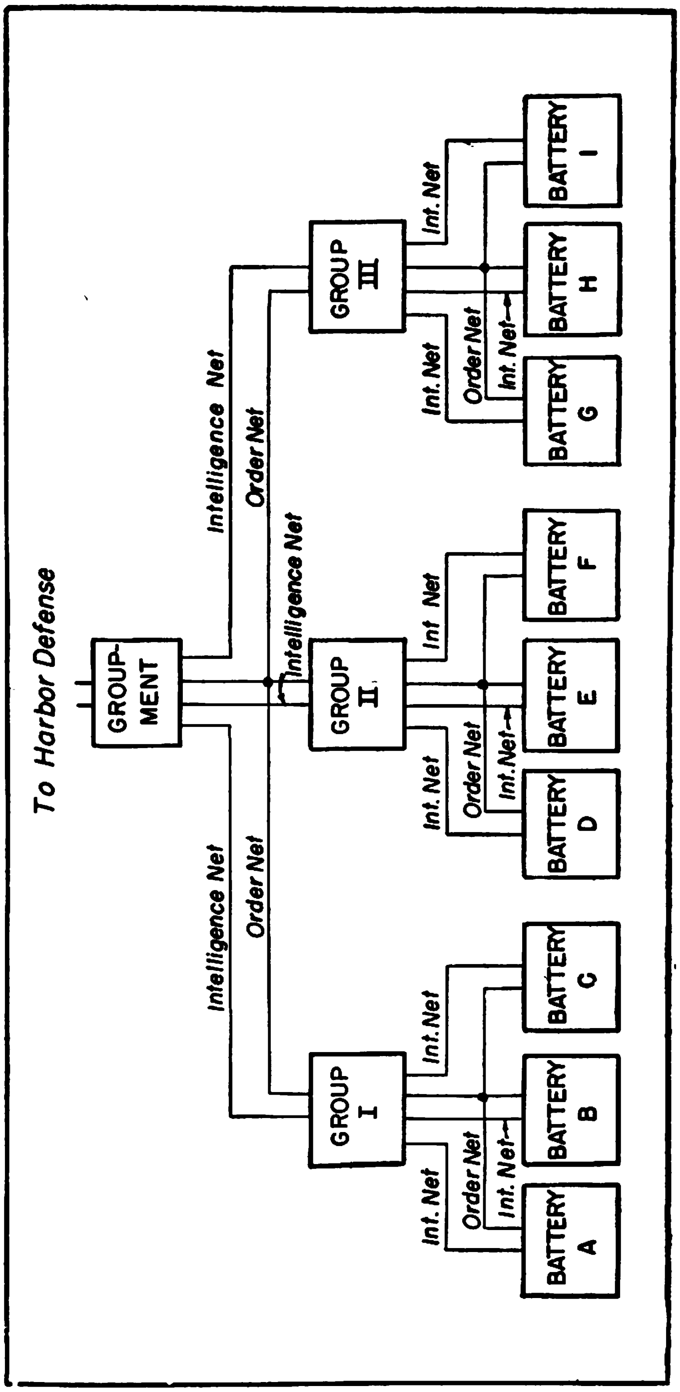


FIGURE 165.—Groupment and group communication.

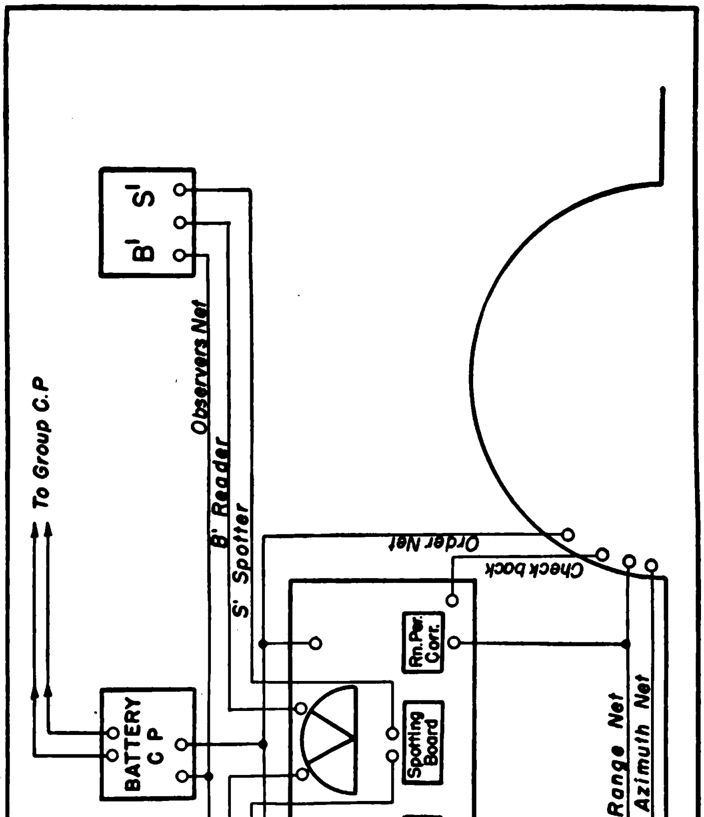


FIGURE 166.—Fire-control telephone system for a fixed battery.

SECTION IV

RADIO COMMUNICATION

114. General.—*Q*. What is radiotelegraphy? *A*. Radio communication by means of International Morse Code.

Q. What is radiotelephony? *A*. Radio communication by means of voice signals.

Q. Radio is used as a means of communication between what units? *A*. All combat units down to and including battalions; individual airplanes; and certain individual vehicles. Under certain situations the battery must also be included.

Q. What are some advantages of radio as a means of communication? *A*. It is independent of roads and traffic and quick to operate. There is no wire to lay or maintain.

Q. What are some disadvantages of radio? *A*.

(1) Messages can be intercepted by the enemy.

(2) The number, type, and location of sets in an area may give the enemy an estimate of our dispositions and strength.

(3) A particular frequency or band can be blocked, thereby interfering with communication.

(4) Weather conditions may adversely affect range and quality.

Q. What are important considerations when locating radio stations? *A*.

(1) Radio stations should be in quiet localities protected from weather and enemy fire.

(2) They should not be placed close to sources of possible radio interference such as power lines, telegraph and telephone lines, and other radio stations.

(3) The location should be such that the antenna is in the clear and elevated.

(4) The presence of buildings, hills, woods, and other objects may screen the waves.

Q. What are some of the uses of radio in the military service, other than transmission of ordinary messages? *A*.

(1) *Reception.*—(*a*) Location of enemy radio stations on land, sea, or air.

(*b*) Interception of enemy radio traffic.

(*c*) Interception of friendly radio traffic for supervisory purposes.

(*d*) Collection of upper air meteorological data.

(2) *Transmission.*—(*a*) Meteorological messages.

(*b*) Time signals.

(*c*) Press reports.

(*d*) Propaganda.

115. Definitions.—*Q.* What is meant by "break-in operation"? *A.* Operation wherein the receiving operator can interrupt the transmitting operator at any time.

Q. What is meant by "call sign"? *A.* A group of letters, or of letters and numerals, used for station identification.

Q. What is meant by "frequency assignment"? *A.* The frequency assignment of a station is the frequency or frequencies usually expressed in kilocycles (kc.) or megacycles (mc.), at which the station is authorized to operate.

Q. What is meant by "heading"? *A.* The heading of a message is that part which appears before the text or body begins.

Q. What is meant by "intercept station"? *A.* A station that copies enemy radio traffic for the purpose of obtaining information or friendly traffic for the purpose of supervision.

Q. What is meant by "internet traffic"? *A.* Traffic between stations which are not assigned to the same net.

Q. What is meant by "linking station"? *A.* A station used for the relay of messages from one net to another.

Q. What is meant by "position finder station"? *A.* A station containing one or more radio receivers capable of finding the location from which incoming radio waves are arriving at the receiver.

Q. What is meant by "mobile station"? *A.* A station that normally operates from a stationary location but which can be rapidly transported to another location.

Q. What is meant by "vehicular station"? *A.* A station so installed in a vehicle that it is capable of operation with the vehicle in motion.

Q. What is meant by "net call sign"? *A.* A call sign used to call all stations in a net.

Q. What is meant by "service"? *A.* The service of a message consists of the notations made on a message by transmitting and receiving operators.

Q. What is meant by "station log"? *A.* A chronological record of traffic kept at a station.

Q. What is meant by "traffic"? *A.* Traffic consists of all transmitted and received messages.

Q. What is meant by "transmission"? *A.* A complete communication between stations including all queries, repeat-backs, and receipts.

Q. What is meant by "trick" or "watch"? *A.* A tour of duty as an operator.

116. Radio nets and net control stations.—*Q.* What is a radio net? *A.* In order that radio communication may follow the proper channels of tactical command, the radio station of a superior unit and the radio stations of the next subordinate units are grouped together for operation. The superior unit together with its subordinate units are called a radio net.

Q. What are tactical radio nets? *A.* Tactical nets are made up of mobile or vehicular low-powered radio stations of tactical units in the field. They are designated by a name indicative of the superior headquarters in the net.

Q. How is the transmission of messages usually controlled in a net? *A.* In each net one station is designated as net control station (NCS). The NCS is charged with clearing traffic within the net, working the internet traffic, and maintaining order within the net.

Q. What is a directed net? *A.* In a directed net no station except the NCS can communicate, except for the transmission of "urgent" messages, with any other station without first obtaining permission of the NCS. A free net on the other hand is not so restricted. Directed nets are used only when the NCS cannot maintain control otherwise.

Q. How is interference between various nets avoided? *A.* Each net is assigned a definite frequency on which it must operate.

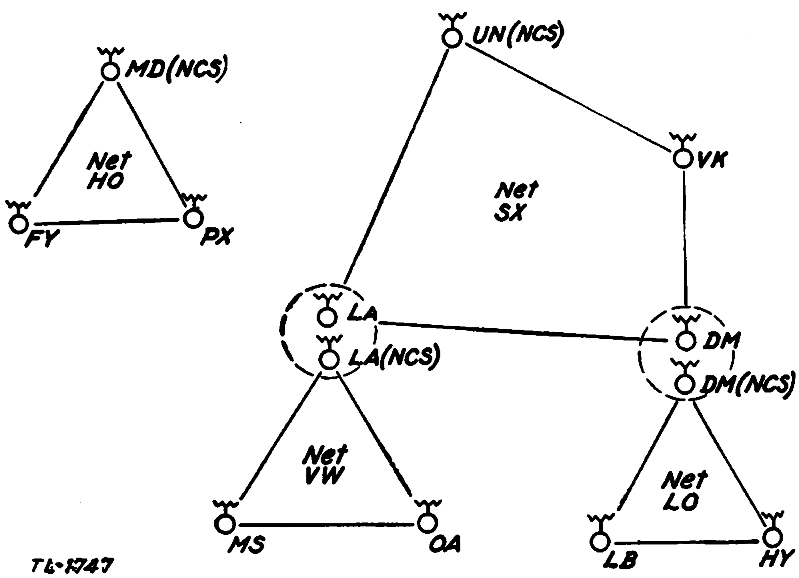


FIGURE 167.—Tactical radio nets.

117. Operation.—*Q*. Give some of the transmitting rules that must be observed by an operator. *A*.

(1) An operator will listen on the transmitting frequency assigned his station before making any call or other transmission. If there are other stations working on the frequency, he will not interrupt communication unless such interruption is warranted by the class of his traffic.

(2) All transmissions must be as short and concise as possible. An operator may test his transmitting set before the first transmission by sending a few "V's" followed by his own station call sign.

(3) Messages and transmissions must be sent at a speed which will allow the receiving station to copy them on the first transmission. Thus no transmissions should be faster than the slowest operator in a net can receive them.

(4) Particular care is necessary that all call signs are made slowly and distinctly.

(5) The procedure sign for "Wait" is used when an immediate answer cannot be given.

(6) An "End of message" sign will always be used.

Q. Can the call sign or frequency of another station or net be used? *A*. The use of any call sign or frequency not assigned by higher headquarters is prohibited.

Q. Where is information as to call signs and frequencies published? *A*. It is published in Signal Operation Instructions.

Q. What is "Radio day"? *A*. It is the 24-hour period covered by a complete set of station records. It commences at midnight of the time zone in which the station is located and ends at the following midnight of the same zone. All station records of all stations in the net will be opened and closed in accordance with this rule.

Q. What is the operator's personal sign? *A*. Each operator is identified by a personal sign of one or two letters. No two operators in the same station will use the same sign. It is never transmitted but is used only in keeping of station records.

Q. What are procedure signals? *A*. Arbitrary, nonsecret signals which have a specific meaning. The use of such signals cuts down materially on the time required by operators to handle traffic.

Q. Where are procedure signals prescribed? *A*. In the Joint Army and Navy Radiotelegraph and Radiotelephone Procedure; short title JANP.

Q. How may interference by hostile radio stations be minimized? *A*.

(1) By training radio operators in the strict observance of radio discipline and radio security.

(2) By the use of prearranged signals or groups of letters preceding each transmission to identify the station making the transmission.

(3) By frequent changes and limited use of call signs.

(4) By limiting the number of stations in a net.

Q. What messages are transmitted by the radio station? *A*. Only those authorized by competent authority.

Q. If a message is received in code, where is it decoded? *A*. The message center.

Q. What essential elements are recorded in the station log? *A*.

(1) Time entry for each notation.

(2) Operators on duty.

(3) Opening and closing of stations.

(4) Causes of delays in traffic.

(5) Frequency adjustments and changes.

(6) Unusual occurrences such a procedure violations and verifications.

Q. If the capture of station records by the enemy seems certain, what action should be taken? *A*. They should be destroyed.

Q. State the primary and secondary mission of radio station operators. *A*.

(1) *Primary.*—Closest cooperation with the message center to insure delivery of the message to the addressee without delay and exactly as written by the writer.

(2) *Secondary.*—The keeping of station records.

Q. What benefits are derived from station records? *A*. They are valuable in determining errors made by operating personnel, causes of delays in traffic, and in determining the proper actions necessary for increasing traffic efficiency. They are useful in the recovery of lost messages and as verification records.

Q. What is the range of the set furnished to your organization—

(1) Using radiotelephone?

(2) Using radiotelegraph? *A*. See the operating instruction pamphlet issued with the set.

Q. Demonstrate the proceedure in setting up a radio set in the field. *A*. (Practical demonstration.)

Q. Demonstrate the operation of the field power unit. *A*. (Practical demonstration.)

Q. Demonstrate the operation of the radio set. *A*. (Practical demonstration.)

Q. Demonstrate ability to send and receive radiotelegraph messages. *A*. (Practical demonstration.)

Chapter 12

SUPPLIES

118. Supply platoon.—*Q*. What element of a regiment or separate battalion is responsible for the operation of the supply functions (except ammunition) of the unit? *A*. The supply platoon of the regimental or separate battalion headquarters battery.

Q. Who supervises the operation of the supply platoon? *A*. The unit supply officer.

Q. Of what elements is the supply platoon comprised? *A*. A platoon headquarters and one or more battalion sections. One battalion section is provided for each battalion of the unit of which the supply platoon is a part.

Q. What is the purpose of a battalion section? *A*. It supplies a particular battalion. If a battalion is detached from the regiment its battalion section normally accompanies it and functions for the supply of the battalion under the supply officer of the unit to which the battalion is attached.

119. Mechanics and methods of supply.—*Q*. How are supplies delivered to the supply platoon when operating in the field? *A*.

(1) They may be delivered to the camp or bivouac of the supply platoon by the train of the next higher administrative unit.

(2) The trucks of the supply platoon may go in convoy to the designated depot or distributing point to secure the supplies.

Q. How are supplies delivered to the batteries? *A*.

(1) The supply platoon trucks may deliver the supplies directly to the batteries.

(2) The supply platoon may establish a distributing point and issue supplies to battery trucks at that point.

(3) Battery trucks may be attached to the supply platoon convoy and go to the depot or distributing point established by the higher administrative unit to receive their supplies.

Q. In the field what written requests are necessary to obtain rations? *A*. In the field no requisition is necessary. A record of the number of men present on the morning report of the regiment is forwarded each day to higher headquarters, and rations are issued daily to supply the number of men reported.

Q. How are gasoline and oil issued in the field? *A*. A reserve of gasoline and oil in containers is carried in each unit. As far as practicable, initial distribution of this reserve is made to each motor vehicle. After the initial issue of gasoline and oil, each motor vehicle operating between army supply points and unit areas replenishes its supply of gasoline and oil at the most convenient class III supply point established by the army. Vehicles operating in forward areas are resupplied with gasoline and oil by exchanging empty containers for full ones brought forward from army supply points either by regimental or divisional transportation.

Q. Name and describe the various field rations. *A*.

(1) *Field ration A*.—This ration corresponds to the peacetime garrison ration and is generally perishable. Being perishable, it is not suitable as a reserve ration.

(2) *Field ration B*.—This ration is the same as field ration A except that nonperishable substitutes replace perishable items. This ration is suitable for reserve purposes.

(3) *Field ration C*.—This ration is a cooked balanced ration in cans. Each ration consists of three cans of prepared meats and vegetables and three cans of crackers, sugar, and soluble coffee. As this ration is not perishable, it is suitable for use as a unit reserve or as an individual reserve.

(4) *Field ration D*.—This ration consists of three 4-ounce chocolate bars per ration. It is a nonperishable ration and is suitable for use as an individual reserve.

Q. For what purpose is the A ration employed? *A*. It is issued daily from class I railheads to all divisions and other units not actively engaged with the enemy.

Q. What ration is issued to units engaged in battle? *A*. One of the nonperishable rations or combinations thereof.

Q. What method is sometimes employed by supply officers of regiments (or battalions) engaged in combat to facilitate the issue of rations? *A*. A rear echelon may be established where all kitchens are assembled. From this point trucks are dispatched with cooked meals to locations from which the food can be carried to the troops.

Q. What method is employed to determine the quantities of the various articles of the ration which should be issued by the regiment to the various subordinate units? *A*. The components of the prescribed ration are listed in regulations published either by the War Department or by the commander of the field forces. By using this list of ration components and the strength returns submitted by the various batteries, the regimental supply officer can determine the quantity of each item of the ration to which a unit is entitled.

Q. What practical difficulties may be encountered in attempting to divide the ration articles equitably? *A*.

(1) Meat is received in the form of large cuts such as fore and hind quarters of beef. In dividing up the meat, consideration must be given to the amount of bone and other waste material in different parts of the cut if an equitable division of the meat is to be made. The problem is further complicated by the difficulty of cutting frozen meat.

(2) Sugar, flour, and similar bulk foods will usually be received in 100-pound sacks which must be broken down into smaller quantities for issue to the various units. Care must be taken to reduce losses to a minimum during this handling.

(3) Where the allowances per man are small as in the case of pepper and similar items, or where the quantity of an item to which a unit is entitled is slightly less or greater than the size container in which the item is issued, it may be desirable to issue the item in whole containers, making the necessary adjustment on succeeding days.

(4) In the case of canned articles equitable division is complicated by the size of the smallest unit of issue, as a No. 10 can. This may result in a shortage or overage for a particular unit of a considerable portion of that component. The supply officer may solve this problem by having units provide suitable containers in which portions of the contents of opened cans may be placed, thereby permitting an accurate division of the canned items. If this is not done, units receiving overages will build up a supply of remnants that usually will not be readily usable.

Q. How are supplies secured in peacetime in garrison? *A*.

(1) Rations are drawn by each battery from the commissary.

(2) Clothing is drawn by each battery from the quartermaster warehouse.

(3) Other supplies are drawn from quartermaster, ordnance, engineer, or signal warehouses by the supply officer and issued to the batteries.

120. Handling and storing supplies, including safety precautions.—*Q*. What points should be considered when storing supplies? *A*.

(1) They should be reasonably secure against theft.

(2) They should be protected from the deteriorating effects of weather including excessive heat, excessive cold, or moisture.

(3) They should be conveniently placed and segregated to facilitate handling.

(4) Maximum permissible floor load must not be exceeded.

(5) When supplies must be stored in the open, they should be kept off the ground by placing them on dunnage such as logs, stones, old crates, or any other suitable material available, and kept covered with tarpaulins or other waterproof coverings.

Q. What provision must be made for the storage of inflammable materials? *A*. They must be segregated from other supplies, preferably in a separate building.

Q. How is woolen clothing protected from moths? *A*. When woolen clothing is unpacked and placed on shelves or in bins for issue, sprinkle napthalene around the clothing in ample quantities. If the clothing is repacked, line the box with wrapping paper and sprinkle napthalene between the folds of the clothing and between layers. Similar precautions should be taken with woolen blankets.

Q. What safety precautions are necessary when handling and storing gasoline? *A*.

(1) Keep open fires away.

(2) See that gasoline tank trucks have a chain attached which drags on the ground to carry off static electricity which might set fire to the gasoline.

(3) Allow no smoking in the vicinity of places where gasoline is stored or is being handled.

(4) When gasoline is to be stored in cans, the cans of gasoline must be examined for leaks before they are placed in the storehouse.

(5) Special fire-fighting equipment such as sand and carbon tetrachloride types of fire extinguishers should be provided in the storage area.

Q. How should trucks be loaded? *A*. Heavy goods should be on the bottom and toward the rear. Top-heavy swaying loads are dangerous. Sacked goods should be firmly placed and pyramided to prevent shifting and wear from friction. Baled goods should never be placed so as to extend over the sides of the truck. Carefully balanced loads will increase the capacity, as most loads are limited by bulk rather than weight.

Q. Why is the keeping of used rags in storehouses or storage spaces considered to be a dangerous practice? *A*. The rags may become ignited by spontaneous combustion.

121. Capacities of vehicles.—*Q*. Where is the maximum pay load, road and cross-country, and the maximum tow load for a particular vehicle shown? *A*. On the vehicle name and caution plate on the dashboard. These loads should never be exceeded except in case of emergency, and then only when specially authorized.

Q. How can overloading of a vehicle be determined when no scales are available and no weights are shown on the cargo? *A.* By noting the position of the rear springs. The driver should be familiar with the appearance of the springs when the truck is carrying its maximum authorized load. Any position of the spring ends below this point indicates that the vehicle is overloaded.

CHAPTER 13

GENERAL SUBJECTS

SECTION I

NOMENCLATURE, ACTION, AND MAINTENANCE OF SMALL ARMS AND THEIR AMMUNITION

122. U. S. caliber .30 rifle, M1903.—*a. Nomenclature and action.*—*Q.* By what other name is the M1903 rifle often called? *A.* It is popularly referred to as the "Springfield rifle," because it was first made at the Springfield Armory, Springfield, Mass.

Q. How would you classify it according to its method of operation? *A.* It is a breech-loading bolt action magazine rifle.

Q. What is meant by caliber .30? *A.* Caliber .30 means that the distance between two directly opposite lands in the barrel, expressed in inches, is $^{30}/_{100}$ of an inch.

Q. What are the lands and grooves? *A.* The lands are the raised portions of the bore and the grooves are the spaces between the lands.

Q. What direction of twist do the lands and grooves in the bore give the bullet? *A.* A right twist, or clockwise as seen from the breech.

Q. How does this affect the bullet? *A.* The rotation keeps the bullet from tumbling in its flight, but also causes it to drift slightly to the right.

Q. In firing, should any allowance be made for drift? *A*. No. This is automatically corrected for in the construction of the rear sight leaf.

Q. What ranges can be set on the sight leaf? *A*. Ranges from 100 to 2,850 yards.

Q. What is the weight of the rifle? *A*. About 8¾ pounds.

Q. What is the length of the rifle? *A*. About 43 inches.

Q. What is the muzzle velocity of the ball cartridge? *A*. 2,700 feet per second.

Q. What is the muzzle velocity of the guard cartridge? *A*. 1,200 feet per second.

Q. How many shots can be fired without reloading? *A*. The magazine of the rifle will hold five cartridges and one additional cartridge may be inserted in the chamber, thus making the maximum capacity of the rifle, for any one loading, six shots.

Q. What is meant by the balance of the rifle and where it is located? *A*. As the name implies, it is where the rifle balances when held in the hand. It is just below the windage scale and in front of the floor plate.

Q. Point out the following parts:

Barrel.	Slide screw.	Ejector.
Front sight.	Range scale.	Magazine.
Stacking swivel.	Bolt.	Guard.
Stock.	Bolt handle.	Trigger.
Upper band.	Floor plate.	Lower band.
Lower band swivel.	Sleeve.	Butt swivel.
Grasping groove.	Firing pin.	Butt plate.
Hand guard.	Firing pin sleeve.	Bayonet.
Rear sight.	Striker.	Bayonet guard.
Movable base.	Main spring.	Bayonet grip.
Windage screw.	Extractor.	Bayonet catch.
Windage scale.	Safety lock.	Oiler and thong case.
Drift slide.	Cut-off.	
Slide.	Cocking piece.	Brush and thong.

A. See accompanying figures and the rifle itself.

Q. What does the letter "U" on the lower band mean? *A*. If the band is taken off, it should be put back with the "U" up, as the band is tapered to fit the barrel and stock.

Q. Explain the working of the extractor. *A*. In loading from the magazine the hook of the extractor catches in the groove on the cartridge case as the follower pushes it up from the magazine.

The hook of the extractor continues to hold the cartridge case against the head of the bolt until the bolt is drawn fully to the

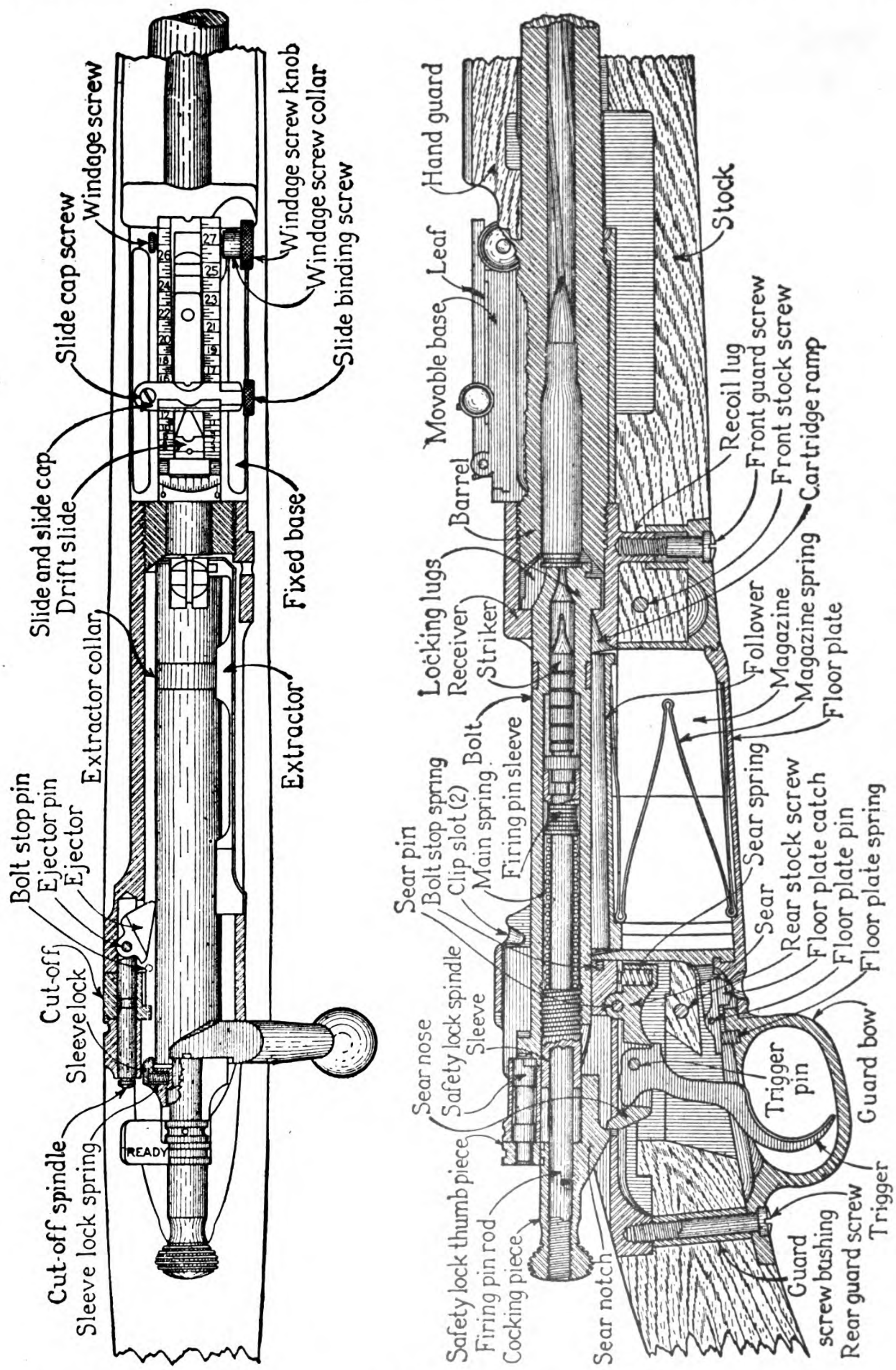


FIGURE 168.—Mechanism of M1903 rifle.

rear. When the bolt is rotated and drawn to the rear, the extractor brings the cartridge case back with it.

Q. What does the ejector do? *A*. When the bolt is almost fully back, the top locking lug strikes the heel of the ejector and throws the point of the ejector suddenly to the right. As the bolt continues to move back, carrying the cartridge case with it, the ejector hits the rear face of the cartridge case and throws it out of the receiver.

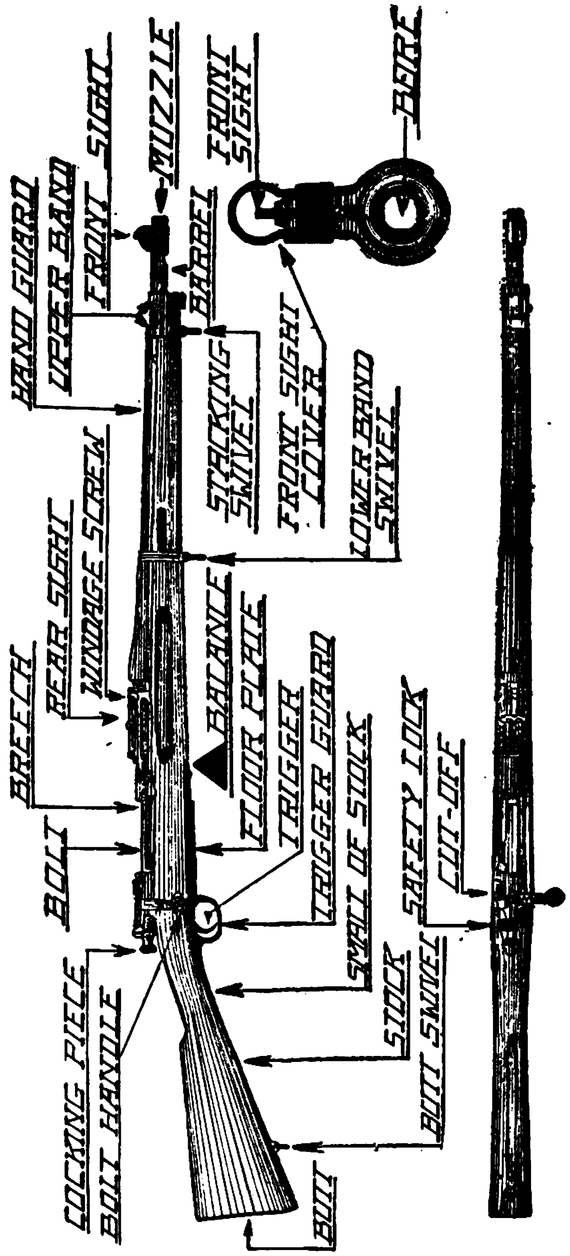


FIGURE 169.—External parts of M1903 rifle.

Q. When firing how can you tell when the last cartridge in the magazine has been fired? *A*. After the last cartridge has been fired and the bolt drawn fully to the rear, the follower rises and holds the bolt open to show that the magazine is empty.

Q. Describe the normal open sight. *A*. The top of the front sight appears to be even with the top of the rear sight slide, and the front sight appears in the middle of the rear sight notch.

Q. Describe the normal peep sight. *A*. The top of the front sight appears to be in the center of the peep.

Q. What is battle sight, and what range is battle sight? *A*. The sight when the sight leaf is *down*—range about 547 yards. The sights are alined as for the normal open sight.

Q. In firing with battle sight, how high is the trajectory above the the line of sight at 300 yards? *A*. 2½ feet.

Q. What preparatory instructions should be held before going on the range? *A*. The six steps of preparatory instructions are:

(1) Sighting and aiming exercises (with sighting bar and rest).

(2) Position exercises.

(3) Trigger squeeze exercise.

(4) Rapid fire exercises, in all positions.

(5) Instruction in the effect of wind, sight changes, and use of score book.

(6) Examination before going on the range.

Q. What do you mean by the "zero" of a rifle? *A*. The point at which the rear sight must be set for both elevation and windage for any particular range, in order to hit the center of the bull's-eye on a normal day when there is no wind.

FIGURE 170.—Standing position, showing hasty sling adjustment.

FIGURE 171.—Kneeling position, showing loop sling adjustment.

Q. What do you mean by "cant" and what is its effect? *A*. It is tilting the rifle to the right or left. The effect is to cause the rifle to shoot low and to the side the rifle is tilted.

Q. Where do you focus your eye when aiming a rifle? *A*. On the target.

Q. In firing at a vertical target what is the rule for correcting your fire in elevation? *A*. Square the range expressed in hundreds of yards. The result is the number of inches on the target that the next shot will strike above (or below) if the rear sight is raised or lowered 100 yards.

Example: When firing at the 200-yard range, raising the rear sight 100 yards will move the next shot 4 inches up on the target.

Q. To shoot to the right (or left), which way would you move the sight? *A*. To shoot to the right move the movable base of the sight to the right. To shoot to the left move the movable base of the sight to the left.

Q. How much does one point on the windage scale correct for? *A*. 4 inches for every 100 yards of range; so at 300 yards range one point corrects for about 12 inches.

Q. How do you figure the effect of a cross wind? *A*. Multiply the range in hundreds of yards by velocity of the wind divided by 10 to find the number of quarter points correction necessary.

Example: When firing at the 200 yard range, a 10-mile wind calls for ½ point correction.

Q. What is the smallest graduation on the windage scale? *A*. A point—*not* a quarter point.

Q. In what direction do you move the sight to correct for wind effect? *A*. Always into the wind.

Q. How do you aim when using guard ammunition? *A*. Use battle sight and aim at the hips.

Q. What are the positions for rifle firing? *A*. Standing, kneeling, sitting, and prone.

Q. Describe and demonstrate the firing positions. *A*. For all positions face half right from direction of fire and then take the position. The rifle then makes an angle of 45° with the body and should point easily and naturally at the target. The right hand grasps the small of the stock, thumb either around or along the stock; the left hand is near the lower band swivel, piece resting on the palm and in the crotch between thumb and fingers, left elbow as nearly directly under the rifle as possible. The neck and jaw are pressed firmly against the stock. The trigger is squeezed with the first or second joint of the right forefinger. Standing position—feet 12 to 24 inches apart. Kneeling position—the left lower leg is vertical, point of left elbow just over point of knee, the firer sitting on right heel or side of right foot. Sitting position—feet 12 to 24 inches apart and dug into ground, upper arms braced against insides of knees. Prone position—legs straight and well apart, insides of feet flat on ground (or nearly so), shoulders raised on elbows. (See figs. 170 to 173, incl.)

FIGURE 172.—Sitting position.

FIGURE 173.—Prone position.

Q. What is the purpose of the sling? *A*. It is used to carry the rifle on long marches, and to afford a steady position in firing.

Q. How is the sling used in firing? *A*. There are two adjustments called the hasty sling and the loop adjustment. (See figs. 170 and 171.)

Q. What is the most important thing in successful rifle shooting? *A*. Correct trigger squeeze.

Q. Explain how to squeeze the trigger correctly. *A*. The trigger should never be jerked as this always spoils the aim. The rifleman alines his sights accurately on the bull's-eye, and when he has them alined he slowly squeezes the trigger. If the sights wander off the bull's-eye, he stops squeezing the trigger, but holds what he has taken up. He brings his sights back into alinement and then continues to squeeze the trigger. The trigger is squeezed only when the sights are on the bull's-eye. After two, or possibly three squeezings, the rifle goes off with the sights properly alined. This procedure is the secret of successful rifle shooting.

Q. What mechanisms is the soldier permitted to disassemble? *A*. The bolt and magazine mechanisms only.

Q. Describe how to disassemble and assemble the bolt mechanism. *A*. (1) *To disassemble bolt mechanism.*—(*a*) Place the cut-off at the center notch.

(*b*) Cock the piece and turn the safety lock to a vertical position.

(*c*) Raise the bolt handle and draw out the bolt.

(*d*) Hold bolt in left hand, press sleeve lock in with thumb of right hand to unlock sleeve from bolt, and unscrew sleeve by turning to the left.

(*e*) Hold sleeve between forefinger and thumb of the left hand, draw cocking piece back with middle finger and thumb of right hand,

turn safety lock down to the left with the forefinger of the right hand and allow the cocking piece to move forward in sleeve, thus partially relieving the tension of mainspring.

(*f*) With the cocking piece against the breast, draw back the firing pin sleeve with the forefinger and thumb of right hand, and hold it in this position while removing the striker with the left hand.

(*g*) Remove firing pin sleeve and mainspring.

(*h*) Pull firing pin out of sleeve.

(*i*) Turn the extractor to the right, forcing its tongue out of its groove in the front of the bolt, and force the extractor forward and off the bolt.

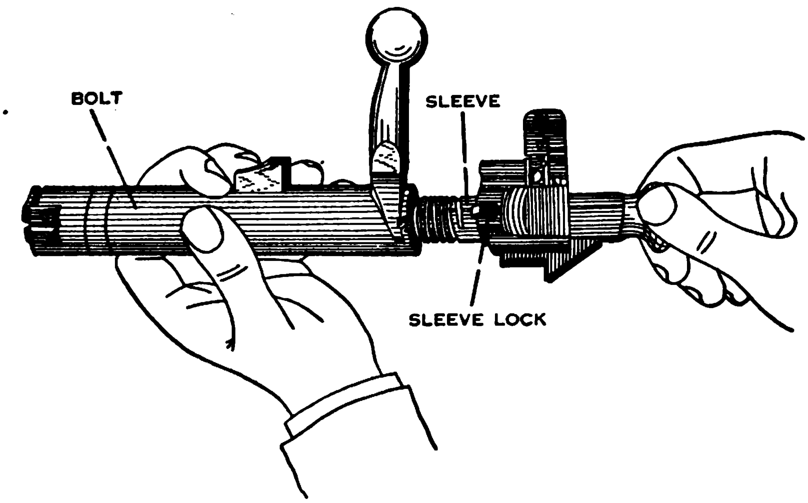


FIGURE 174.—Disassembling the bolt mechanism.

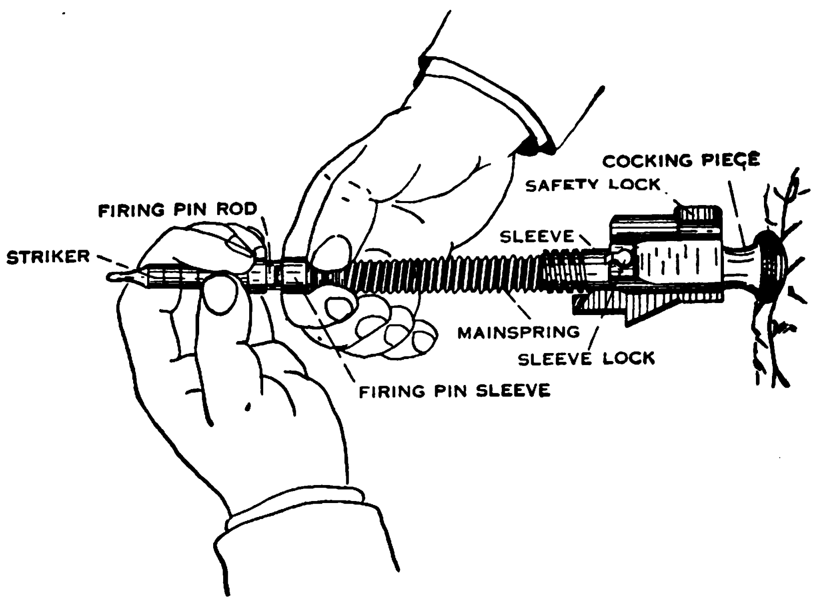


FIGURE 175.—Firing pin.

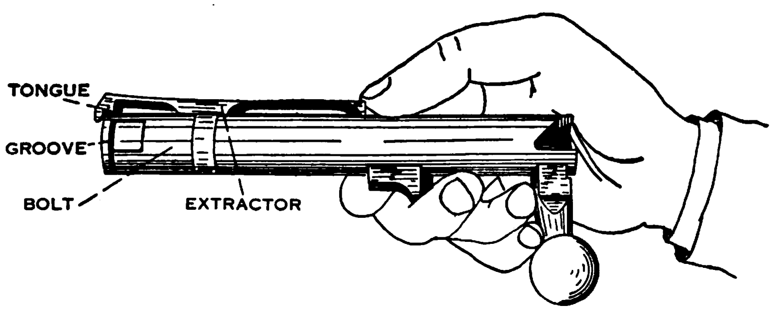


FIGURE 176.—Bolt.

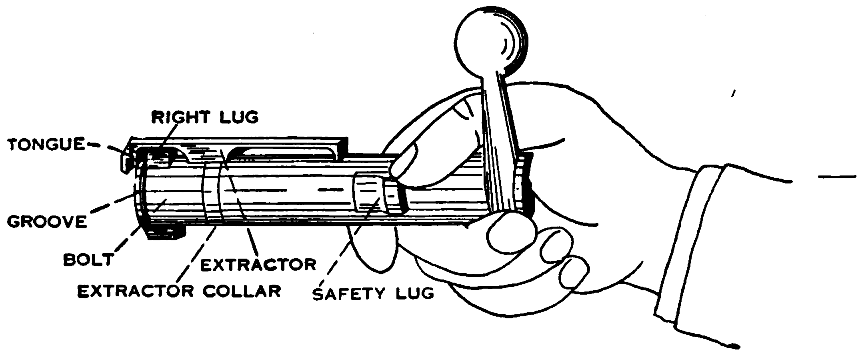


FIGURE 177.—Bolt.

(2) *To assemble bolt mechanism.*—(*a*) Grasp with the left hand the rear of the bolt, handle up, and then turn the extractor collar with the thumb and forefinger of the right hand until its lug is on a line with the safety lug on the bolt.

(*b*) Take the extractor in the right hand and insert the lug on the collar in the undercuts in the extractor by pushing the extractor to the rear until its tongue comes in contact with the rim on the face of the bolt (a slight pressure with the left thumb on the top of the rear part of the extractor assists in this operation).

(*c*) Turn the extractor to the right until it is over the right lug.

(*d*) Take the bolt in the right hand and press the hook of the extractor against the butt plate, or some rigid object, until the tongue on the extractor enters its groove in the bolt.

(*e*) With the safety lock turned down to the left to permit the firing pin to enter the sleeve as far as possible, assemble the sleeve and firing pin.

(*f*) Place the cocking piece against the breast and put on main spring, firing pin sleeve, and striker.

(*g*) Hold the cocking piece between the thumb and the forefinger of the left hand; by pressing the striker point against some substance, not hard enough to injure it, force the cocking piece back until the safety lock can be turned to the vertical position with the right hand.

(*h*) Insert the firing pin in the bolt and screw up the sleeve (by turning it to the right) and until the sleeve lock enters its notch on the bolt.

(*i*) See that the cut-off is at the center notch; hold the piece under floor plate in the fingers of the left hand, the thumb extending over the left side of the receiver; take bolt in right hand with safety lock in a vertical position and safety lug up; press rear end of follower down with left thumb and push bolt into the receiver.

(*j*) Lower bolt handle, turn safety lock and cut-off down to the left with right hand.

Q. Describe how to disassemble and assemble the magazine mechanism. *A*.

(1) *To disassemble magazine mechanism.*—With the bullet end of a cartridge press on the floor plate catch (through the hole in the floor plate), at the same time drawing the bullet to the rear; this releases the floor plate. Raise the rear end of the first limb of the magazine spring high enough to clear the lug on the floor plate and draw it out of its mortise; proceed in the same manner to remove the follower.

(2) *To assemble magazine spring and follower to floor plate.*—Reverse operation of disassembling. Insert the follower and magazine spring in the magazine, place the tenon on the front end of the floor plate in its recess in the magazine, then place the lug on the rear end of the floor plate in its slot in the guard, and press the rear end of the floor plate forward and inward at the same time, forcing the floor plate into its seat in the guard.

b. Maintenance of rifle.—*Q*. What causes the most damage to a rifle when it is not properly cared for? *A*. Water and perspiration. If allowed to remain on the metal parts of a rifle moisture will form rust and the surface of the metal will become "pitted."

Q. How is a rifle protected from water and perspiration? *A*. By removing all moisture from the metal parts and covering them with a coating of oil or grease.

Q. Why should a rifle be cleaned after daily drill? *A*. Because handling the weapon removes oil and allows moisture from the hands to get on it.

Q. How do you clean a rifle after daily drill? *A*. Rub the outside, including the stock and sling, with a rag that has been slightly oiled, and then clean it with a perfectly dry rag. Swab the bore with an oily flannel patch and then with two or three perfectly dry ones. Dust out all screw heads and crevices with a small clean brush. Immediately after cleaning, swab the bore with a flannel patch saturated

with oil (or grease), finally drawing the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling. Wipe over all metal parts including the bolt mechanism and magazine, with an oily rag and put a few drops of sperm oil on all cams and working surfaces. Put a teaspoonful of linseed oil in the palm of the hand and polish the stock.

Q. Should a rifle be covered when stored in the gun rack? *A*. No. Canvas covers collect moisture which causes the rifle to rust underneath the cover. *The use of rifle covers is prohibited.* (Gun racks will be covered temporarily when barracks are being swept.)

Q. Should a rifle be stored in a gun rack (or any other place) without a protective coating of oil? *A*. No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

Q. How is the sling cleaned? *A*. First wash with a sponge well lathered with castile soap. When partially dry, apply a lather of saddle soap. When this is nearly dry, rub with a dry cloth until the sling is polished. Dry the sling in a cool place. Never dry leather in the sun.

Q. What tool should be used to swab the bore of a rifle? *A*. A barracks cleaning rod should always be used. The thong and brush may be used only if the barracks cleaning rod is not available.

Q. From what end of the rifle should the bore be swabbed? *A*. From the breech, removing the bolt to allow cleaning. Never swab the bore from the muzzle end because of possible damage to the muzzle.

Q. What parts of a rifle should be removed for cleaning? *A*. Front sight cover; floor plate and follower; gun sling; oiler, and thong case; and the bolt, which may also be taken apart.

Q. What tool may be used for tightening or loosening screws? *A*. Only a properly fitting screw driver. Never use a bayonet or other substitute, because it will damage the screw heads.

Q. Should a rifle be cleaned before firing? *A*. Yes. Always wipe out the bore with a clean patch before going to the firing point. See that no dust, dirt, mud, snow, rags, patches, or other obstructions are in the bore before firing.

Q. What are the three main forms of the residue left in the bore after a rifle is fired? *A*.

(1) A coating of chemicals left by the burned powder.

(2) Particles of unburned or partially burned powder, called *powder fouling.*

(3) Particles of metal from the jacket of the bullet, called *metal fouling*.

Q. How do they damage a rifle if not removed? *A*. The chemicals attracts moisture from the air which collects in the bore. The powder fouling and the metal fouling trap moisture underneath, against the bore. The moisture causes rusting and pitting of the bore.

Q. How is a rifle cleaned after firing? *A*. The chemicals and powder fouling are dissolved by scrubbing the bore with a dissolving solution of hot water and issue soap or a sal soda solution. Hot water alone may also be used. (Cold water is used only when none of the other agents are available.)

(1) Remove the bolt and place the muzzle in a vessel containing the dissolving solution. Using a cleaning rod and a flannel patch inserted from the breech, pump the solution back and forth through the bore for about one minute.

(2) Next place a brass or bronze wire brush on the rod and run it through the bore all the way down and back three or four times, leaving the muzzle in the dissolving solution. A wire brush is necessary to remove the powder fouling thoroughly.

(3) Next remove the brush from the rod and swab several more times with the dissolving solution.

(4) Then wipe the cleaning rod dry, remove the muzzle from the solution and, using dry, clean flannel patches, thoroughly swab the bore until it is perfectly dry and clean. Also dry off the chamber and other metal parts thoroughly.

(5) Finally, inspect the bore for metal fouling. If no metal fouling is present, prepare the weapon for storage as you do after daily cleaning and place it in the gun rack. The bore must similarly be cleaned and regreased each day for the next succeeding 3 days to insure that no trace of fouling remains.

Q. How do you inspect the bore for metal fouling? *A*. Hold the butt of the rifle pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore, this is metal fouling. It usually occurs within about 6 inches from the muzzle.

Q. What do you do in case you find metal fouling? *A*. Take the rifle to the supply sergeant and ask for instructions.

Q. How is metal fouling removed? *A*. It is removed with metal fouling solution which must be used only by qualified ordnance personnel.

Q. How soon after firing should a rifle be cleaned? *A*. As soon as possible after firing. A weapon should never be put away for the night without being cleaned.

Q. What oils can be used on rifles? *A*.

(1) *For metallic surfaces.*—Sperm oil for lubrication and medium rust-preventive compound for protection from rusting. No other oils should be used unless authorized by the battery commander or his representative.

(2) *For stock.*—Raw linseed oil. When in the field, the stock may be wiped off occasionally with a cloth moistened with sperm oil.

Q. State some of the things one is prohibited from doing with a rifle? *A*.

(1) Except for the removal of those parts permitted for cleaning, a rifle will not be disassembled except by permission of a commissioned officer, and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of rifles must not be polished.

(3) All mutilations such as carving are prohibited.

(4) Nothing except the authorized oils may be used on a rifle.

(5) Weapons must be unloaded before being taken into barracks or tents.

c. Ammunition.—*Q*. What are the parts of a ball cartridge? *A*. Cartridge case, primer, powder, bullet.

Q. What is the purpose of the primer? *A*. To ignite the smokeless powder.

Q. Describe the bullet for ball cartridge. *A*. It has a core of lead and tin composition inclosed in a jacket of gilding metal, covered with a tin wash. The point is very sharp so as to offer little resistance to the air.

Q. Describe the dummy cartridge. *A*. The bullet is similar to the bullet for the ball cartridge. To distinguish it from the ball cartridge, the dummy cartridge has a tinned case provided with six long straight grooves along it and three holes through it.

Q. Describe the guard cartridge. *A*. The guard cartridge is distinguished from the ball cartridge by having either 5 grooves around the case (old style) or six short grooves at the shoulder (new style).

Q. What other type of ammunition may be used for guard purposes? *A*. Where the supply of guard cartridges has been exhausted, the gallery practice cartridge M1919 may be issued for guard purposes.

Q. What is the weight of the ball cartridge? *A*. About an ounce; 100 rounds weigh about 5½ lbs.

Q. How is ammunition packed? *A*. In wooden chests (metal lined) containing 1,200 rounds; in cloth bandoleers holding 60 rounds, and metal clips of 5 rounds each.

Q. What types of service ammunition are used with the M1903 rifle? *A*.

(1) Ball, M2 and M1906.

(2) Tracer, M1.

(3) Armor-piercing, M1.

Q. What distinguishes armor-piercing and tracer ammunition from ball ammunition? *A*.

(1) Armor-piercing is painted black for ¼ inch from the point.

(2) Tracer is painted red for ¼ inch from the point.

Q. At what distance is it dangerous to fire at personnel, representing an enemy, with rifles loaded with blank ammunition? *A*. Never fire at personnel representing an enemy at distances less than twenty yards.

Q. What is the standard type of ball ammunition? *A*. Ball cartridge, caliber .30, M2, is standard.

123. U. S. caliber .30 rifle, M1.—*a. Nomenclature and action.*—*Q*. Briefly describe the U. S. caliber .30 rifle, M1. *A*. The U. S. caliber .30 rifle, M1, is a gas operated, clip fed, self loading, shoulder weapon. The gas generated in a cartridge fired in the rifle is utilized to compress the operating rod spring and compensating spring, to extract and eject the fired case, and to cock the hammer. The operating rod spring and compensating spring, which are meantime forcing the cartridges up in the clip, complete the cycle by closing and locking the bolt. The bolt as it goes forward strips the top cartridge from the clip and chambers it. The rifle is then ready to fire.

Q. What is meant by caliber .30? *A*. Caliber .30 means that the distance between two directly opposite lands in the barrel, expressed in inches, is $^{30}/_{100}$ of an inch.

Q. What are the lands and grooves? *A*. The lands are the raised portions of the bore and the grooves are the spaces between the lands.

Q. What direction of twist do the lands and grooves in the bore give the bullet? *A*. A right twist, or clockwise as seen from the breech.

Q. How does this affect the bullet? *A*. The rotation keeps the bullet from tumbling in flight, but also causes it to drift slightly to the right.

Q. In firing, should any allowance be made for drift? *A*. No. This is automatically corrected for in the construction of the rear sight.

Q. How many cartridges may be loaded in this rifle at one time? *A*. Eight cartridges are loaded in a reversible clip.

Q. What limits the rate of fire? *A*. The rate of fire is limited only by the proficiency of the soldier in marksmanship, and his dexterity in inserting clips into a magazine.

Q. What is the weight of this rifle? *A*. The weight of the rifle is approximately nine pounds and the bayonet an additional pound, while the weight of a loaded clip of cartridges (8 cartridges, M1) is slightly in excess of 0.5 pound.

Q. What is the maximum range graduation on the rear sight? *A*. The maximum range graduation on the rear sight is 1,200 yards.

Q. What is the muzzle velocity of the ball cartridge? *A*. 2,700 feet per second.

Q. What is the muzzle velocity of the guard cartridge? *A*. 1.200 feet per second.

Q. Point out the following parts:

Butt plate.
Rear sight base.
Rear sight elevating knob screw.
Rear sight elevating knob.
Clip latch.
Bolt.
Rear hand guard band.
Rear hand guard.
Lower band.
Front hand guard.
Front sight.
Gas cylinder plug.
Gas cylinder plug screw.
Barrel.
Extractor.
Operating rod.
Rear sight cover.
Aperture.
Stock.
Comb.
Heel.
Toe.
Rear sight nut.
Rear sight windage knob.
Receiver.
Front hand guard ferrule.
Front sight screw.
Gas cylinder.
Stacking swivel.
Stacking swivel screw.
Stock ferrule.
Stock ferrule screw.
Stock ferrule swivel.
Gun sling keeper.
Gun sling hook.
Gun sling long strap.
Gun sling.
Safety.
Trigger.
Trigger guard.
Gun sling loop.
Gun sling short strap.
Butt swivel.

A. See figure 178.

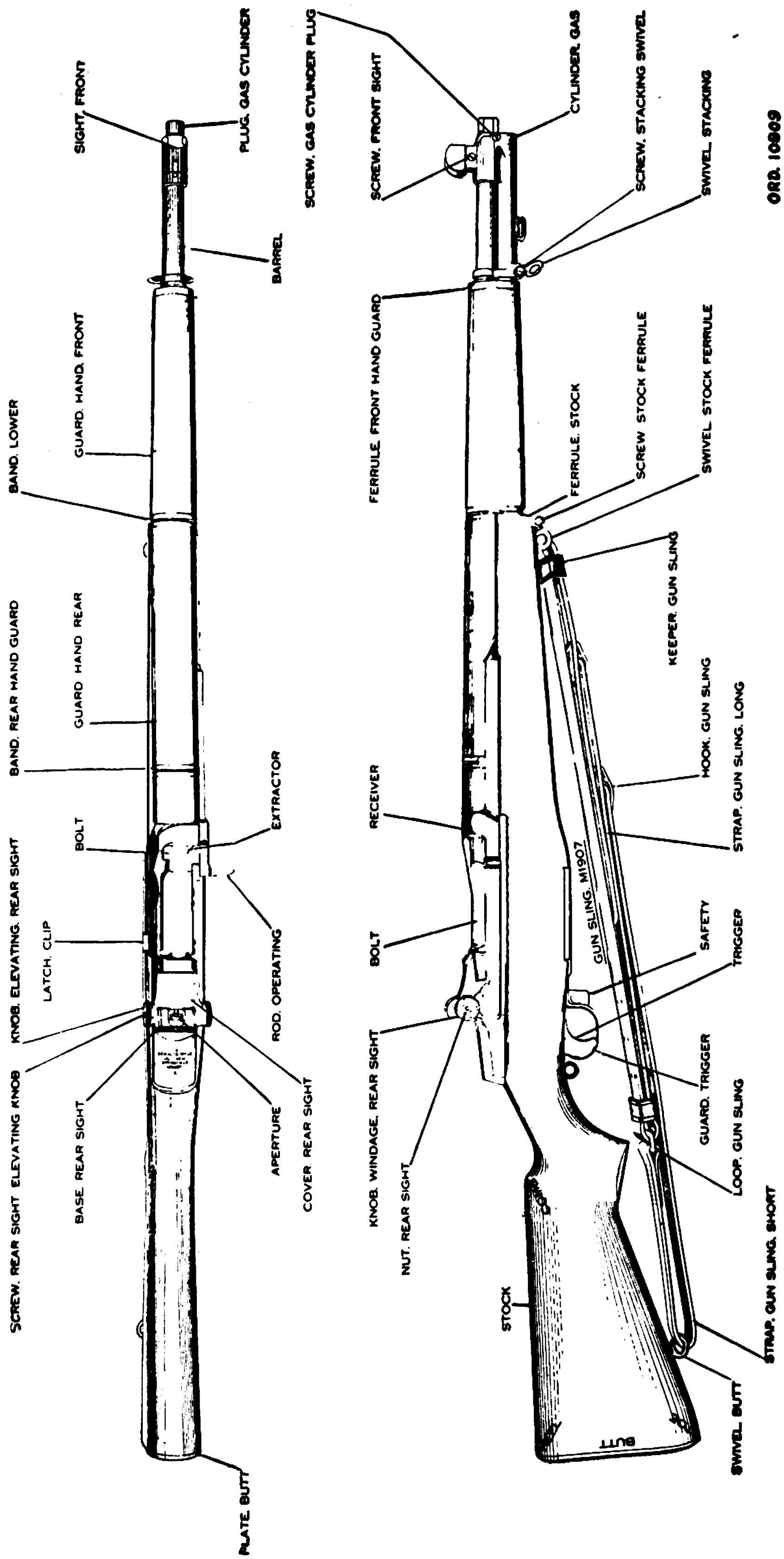


FIGURE 178.—U. S. caliber .30 rifle, M1, right side and top views.

Q. How is the ammunition loaded into the cartridge clip? *A*. A clip loading machine (no more to be issued) is sometimes used to load ammunition into clips. In loading the cartridge clip by hand care must be taken to see that the base of each cartridge is close to the rear wall of the clip so that the inner rib of the clip engages the extractor groove in the cartridge, and that each clip is fully loaded with eight cartridges. For ease in inserting the clip it is preferable to have the uppermost cartridge on the right side of the clip.

Q. How is the clip loaded into the rifle? *A*. The operation of loading is performed with the piece locked, that is, with the safety of the piece in its rearmost position, except in sustained firing. Hold the rifle at the balance in the left hand. With the forefinger of the right hand, pull the operating rod handle smartly to the rear until the operating rod is caught by the operating rod catch. With the right hand take a fully loaded clip and place it on top of the follower. Place the right side of the right hand against the operating rod handle and with the thumb of the right hand press the clip down into the receiver until it engages the clip latch. Swing the thumb to the right so as to clear the bolt in its forward movement and release the operating rod handle. The closing of the bolt may be assisted by a push forward on the operating rod handle with the heel of the right hand.

Q. How is the rifle fired? *A*. The trigger must be squeezed for each shot. After the eighth shot has been fired, the empty clip is automatically ejected upward out of the receiver to the right and the bolt remains open ready for the insertion of another clip. Should the gun be permitted to recoil in such a manner as to cause the trigger to be released and then by a rebound of the shoulder force the gun forward, causing the trigger to strike the trigger finger and be pulled a second time, the firing of a second round may result. *Caution should be exercised against this.*

Q. Can the hammer be cocked without unlocking the bolt? *A*. Yes. In case of misfire or other occasion when it is desired to cock the hammer without unlocking the bolt, unlatch the trigger guard and swing it to its extreme downward position (see fig. 179). Close and latch the trigger guard and the rifle is ready to be fired.

Q. How is the rifle set at safe? *A*. The rifle being loaded, if it is not desired to fire at once, is set at safe by pulling to the rear on the front surface of the safety until it occupies its rearmost position inside the trigger guard. In this position the trigger cannot be pulled. The rifle may be loaded and operated by hand when the

FIGURE 179.—Cocking hammer without unlocking bolt.

safety is on but it cannot be fired. It can only be set at safe when the hammer is cocked. To set the rifle at ready, push safety to its extreme forward position.

Q. How is a loaded clip removed from the magazine without firing the rifle? *A.* To remove a loaded cartridge clip from the magazine of the rifle without firing, hook the right forefinger over the operating rod handle, pull and hold in the extreme rear position, with the left hand over the magazine, using the left thumb to release the clip latch. The clip, with contained cartridges will then be ejected upward out of the magazine into the hand. Do *not* allow the bolt to move forward after pulling it to the rear, as the top cartridge will be moved forward out of its position in the clip, and will prevent the normal ejection.

Q. How is the rifle unloaded? *A.* Pull operating rod handle to rearmost position, thus extracting and ejecting cartridge from the chamber. Hold the operating rod full to the rear and proceed as when removing a loaded clip from the magazine. If it is desired to close the bolt on an empty chamber and retain a partially loaded clip in the magazine, press down on the top cartridge in the clip allowing the bolt to slide forward, being sure that it is fully closed. *This procedure is exceptional as the rifle is normally either loaded or "clear."*

Q. Describe the adjustment of the rear sight. *A.* The rear sight is adjusted vertically by turning the elevating knob, which is on

the left side and has numbered graduations for 200, 400, 600, 800, 1,000, and 1,200 yards' range. Index lines between the numbered lines correspond to 100, 300, 500, 700, 900, and 1,100 yards' range. Adjustment for windage is made by windage knob on the right, each windage graduation representing 4 minutes of angle. The elevating and windage knobs are provided with "clicks" which represent approximately 1 minute of angle or 1 inch at 100 yards. Arrows on knobs indicate direction of rotation for desired changes in point of impact. The rotation of the elevating knob may be eased by forcing the knob outward, away from receiver, while turning.

Q. What safety precautions must be taken with the M1 rifle? *A.* While any cartridges remain in the magazine after a round has been fired, the rifle is ready to fire, and the gun is safe only when it is "cleared." In other words, the gun is never *known* to be safe when the bolt is closed. To clear the gun, pull operating rod fully to the rear, extracting and ejecting cartridge from the chamber, and remove the clip from the magazine *leaving the bolt open.* When the rifle is hot from repeated firing, *a cartridge must not be left in the chamber.* When for any reason firing is suspended for any considerable time *clear the gun.* Overheated cartridges produce abnormal pressures, are liable to preignition, and increase extraction effort to such an extent that the rim of the cartridge case is likely to be pulled off leaving the case in the chamber.

Q. What preparatory instructions should be held before going on the range? *A.* The six steps of preparatory instructions are—

(1) Sighting and aiming exercises (with sighting bar and rest).

(2) Position exercises.

(3) Trigger squeeze exercise.

(4) Rapid fire exercises, in all positions.

(5) Instruction in the effect of wind, sight changes, and use of score book.

(6) Examination before going on the range.

Q. What do you mean by the "zero" of a rifle? *A.* The point at which the rear sight must be set for both elevation and windage for a particular range, in order to hit the center of the bull's-eye on a normal day when there is no wind.

Q. What do you mean by "cant" and what is its effect? *A.* It is tilting the rifle to the right or left. The effect is to cause the rifle to shoot low and to the side the rifle is tilted.

Q. Where do you focus your eye when aiming a rifle? *A.* On the target.

Q. What are the positions for rifle firing? *A*. Standing, kneeling, sitting, and prone.

Q. Describe and demonstrate the firing positions. *A*. For all positions, face half right from direction of fire and then take the position. The rifle then makes an angle of 45° with the body and should point easily and naturally at the target. The right hand grasps the small of the stock, thumb either around or along the stock; the left hand is near the lower band swivel, piece resting on the palm and in the crotch between thumb and fingers, left elbow as nearly as possible directly under the rifle. The neck and jaw are pressed firmly against the stock. The trigger is squeezed with the first or second joint of the right forefinger. Standing position—feet 12 to 24 inches apart. Kneeling position—the left lower leg is vertical, point of left elbow just over point of knee, the firer sitting on right heel or side of right foot. Sitting position—feet 12 to 24 inches apart and dug into the ground, upper arms against insides of knees. Prone position—legs straight and well apart, insides of feet flat on ground (or nearly so), shoulders raised on elbows. (See figs. 170 to 173, incl.)

Q. What is the purpose of the sling? *A*. It is used to carry the rifle on long marches, and to afford a steady position in firing.

Q. How is the sling used in firing? *A*. There are two adjustments, called the hasty sling and the loop adjustment. (See figs. 170 and 171.)

Q. What is the most important thing in successful rifle shooting? *A*. Correct trigger squeeze.

Q. Explain how to squeeze the trigger correctly. *A*. The trigger should never be jerked as this always spoils the aim. The rifleman alines his sights accurately on the bull's-eye; and when he has them alined, he slowly squeezes the trigger. If the sights wander off the bull's-eye, he stops squeezing the trigger, but holds what he has taken up. He brings his sights back into alinement and then continues to squeeze the trigger. The trigger is squeezed only when the sights are on the bull's-eye. After two, or possibly three squeezings, the rifle goes off with the sights properly alined. This procedure is the secret of successful rifle shooting.

b. *Maintenance of rifle*.—*Q*. What causes the most damage to a rifle when it is not properly cared for? *A*. Water and perspiration. If allowed to remain on the metal parts of a rifle, moisture will form rust and the surface of the metal will become "pitted."

Q. How is a rifle protected from water and perspiration? *A*. By removing all moisture from the metal parts and covering them with a coating of oil or grease.

Q. Should a rifle be covered when stored in a gun rack? *A.* No. Canvas covers collect moisture which causes the rifle to rust underneath the cover. *The use of rifle covers is prohibited.* (Gun racks will be covered temporarily when barracks are being swept.)

Q. Should a rifle be stored in a gun rack (or any other place) without a protective oil coating? *A.* No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

Q. How is the sling cleaned? *A.* First wash with a sponge well lathered with castile soap. When partially dry, apply a lather of saddle soap. When this is nearly dry, rub with a dry cloth until the sling is polished. Dry the sling in a cool place. Never dry leather in the sun.

Q. Why should a rifle be cleaned after daily drill? *A.* Because handling the weapon removes oil and allows moisture from the hands to get on it.

Q. What tool should be used to swab the bore of a rifle? *A.* A barracks cleaning rod should always be used. The thong and brush may be used only if the barracks cleaning rod is not available.

Q. What tool may be used for tightening or loosening screws? *A.* Only a properly fitting screw driver. Never use a bayonet or other substitute because it will damage the screw heads.

Q. Describe the care and cleaning of the M1 rifle in garrison and camp. *A.* Rifles should be disassembled only to the extent necessary to insure proper condition and cleanliness. The bore of the rifle is always cleaned with a cleaning rod, from the muzzle. If the length of the cleaning rod is such that contact can be made with the face of the retracted bolt, *the bolt must be protected.* To clean the bore push a lightly oiled patch through it and out the breech end. This should be followed with dry patches until several successive ones come out absolutely clean. Push through the bore a patch saturated with oil, to protect its surface. If local climatic conditions necessitate, bores and chambers may be coated with standard rust-preventive compound. To clean screw heads and crevices use a small cleaning brush or small stick. To clean metal surfaces wipe with a dry cloth to remove moisture, perspiration, and dirt. Then wipe with a lightly oiled cloth using aircraft instrument and machine-gun lubricating oil. This protective film must be maintained *at all times.* To clean the outer surface of the rifle, including the stock, hand guards, and sling, wipe off dirt with a lightly oiled cloth, and clean with soft dry one. In cleaning the bore, care must be taken not to foul the cleaning patch in the gas port. Repeat until several successive patches come out

absolutely clean. Saturate a patch in sperm oil and push it through the bore, holding the rifle, top up, so that some sperm oil will flow into the gas port.

Q. Describe the care and cleaning of the M1 rifle preparatory to firing. *A.* This differs from the procedure described in the care and cleaning of the M1 rifle in garrison and camp in that Dixon's graphite cup grease No. 3 is substituted for aircraft instrument and machine-gun lubricating oil on many of the moving parts of the weapon. The rifle is disassembled and the bore is cleaned and oiled very lightly (*the chamber is not oiled*). Any carbon which may have formed on the gas cylinder plug and the piston head is removed. After thoroughly cleaning and lightly oiling all metal parts a thin uniform coating of the graphite cup grease, referred to above, is applied to the following parts: Bolt lugs including locking and operating, bolt guides, cocking cam on bolt, compensating spring, contact surfaces of barrel and operating rod cam, operating rod guide groove in receiver, and the operating rod spring. *The graphite cup grease should under no circumstances be applied to the follower slide or the under surface of the bolt as the introduction of graphite into the chamber may lead to the generation of excessive pressures.* After the rifle has been assembled all outer surfaces should be rubbed lightly with an oiled rag.

Q. What are the three main forms of residue left in the bore after a rifle is fired? *A.*

(1) A coating of chemicals left by the burned powder and primer.

(2) Particles of unburned or partially burned powder, called powder fouling.

(3) Particles of metal from the jacket of the bullet, called metal fouling.

Q. How do they damage a rifle if not removed? *A.* The chemicals attract moisture from the air which collects in the bore. The powder fouling and metal fouling trap moisture underneath, against the bore. The moisture causes rusting and pitting of the bore.

Q. How do you inspect the bore for metal fouling? *A.* Hold the butt of the rifle pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore this is metal fouling. It usually occurs within about 6 inches from the muzzle.

Q. Describe the care and cleaning of the M1 rifle after firing? *A.* The bore of the rifle must be thoroughly cleaned by evening of the day on which it is fired, and similarly cleaned for the next three

days. Under no circumstances is the use of any metal fouling solution in the rifle permitted. After disassembling the rifle, the barrel and receiver assembly *with the bolt removed* should be supported at an angle of about 45° with the barrel down. *The bore is always cleaned from the muzzle.* A flannel patch saturated with water is pushed through the bore and out the breech end. This is repeated with several patches followed with dry patches until they come out clean and dry. Then one patch saturated with oil is pushed through the bore and two patches inserted in the slot in the chamber cleaning tool, wrapped smoothly about it, and the chamber scrubbed by twisting the tool. If the rifle is not to be fired the following day, proceed as in care and cleaning in *garrison and camp.* However, if the rifle is to be used the next day, the procedure described in care and cleaning of the M1 rifle preparatory to firing should be followed. If the rifle is not to be fired for a considerable period, or if local conditions cause excessive formation of rust, a rust preventive should be applied to the bore and chamber after cleaning; for storage all metal parts should be protected in the same manner. Heavy oil and grease must be removed from the bore and chamber before firing.

Q. Describe the care and cleaning of the M1 rifle on the range. *A.* The rifle must never be fired with any dirt, mud, or snow in the bore, and the chamber should be kept free and clean from any oil or dirt. A patch plug or other obstruction must never be allowed to remain in the chamber or bore and neglect of this precaution may result in serious injury.

Q. Describe the care and cleaning of the rifle in the field. *A.* The rifle must be kept clean and free from dirt, and properly lubricated with graphite cup grease. To obtain maximum efficiency the chamber must be kept clean; additional graphite cup grease is applied to the parts, as prescribed in care and cleaning *preparatory to firing*, at the first opportunity after indications of excessive friction occur; a light coating of oil is kept on all other metal parts; and carbon is removed from the gas cylinder plug and piston head. In general it should not be necessary to remove any parts of the rifle in the field except the trigger housing group and the gas cylinder plug.

Q. State some of the things one is prohibited from doing with a rifle. *A.*

(1) Except for the removal of those parts permitted for cleaning, a rifle will not be disassembled except by permission of a commissioned officer, and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of rifle must not be polished.
(3) All mutilations such as carving are prohibited.
(4) Nothing except the authorized oils may be used on a rifle.
(5) Weapons must be unloaded before being taken into barracks or tents.

TABLE OF STOPPAGES

Malfunction	Cause	Correction by soldier
Clip jumps out on seventh round.	Bent follower rod	Replace.
Failure to extract	(1) Dirty or rough chamber. (2) Restricted gas port	(1) Clean chamber. (2) Clean gas port.
Failure to feed	(1) Dirty or rough chamber. (2) Restricted gas port (3) Dirty rifle or improper lubrication. (4) Bent clip (5) Ruptured cartridge case in chamber.	(1) Clean chamber. (2) Clean gas port. (3) Clean rifle and lubricate. (4) Replace clip. (5) Remove ruptured cartridge case.
Fires automatically	Sear broken or remains in open position.	Replace trigger assembly or hammer spring housing.
Safety releases when pressure is applied on trigger.	Round heel on safety, or broken safety.	Replace safety.
Pull on trigger does not release hammer.	(1) Deformed hammer or trigger or worn trigger pin. (2) Trigger strikes trigger housing.	(1) Replace defective part. (2) Turn in to ordnance.
Hammer releases but gun does not fire.	(1) Bolt not all the way seated. (2) Defective ammunition. (3) Broken firing pin	(1) Clean and lubricate. (2) Discard round. (3) Replaced.
Rear sight elevation jumps.	Loose rear sight nut	Tighten.
Creep in trigger	Burs on trigger or hammer lugs.	Turn in to ordnance.

c. Ammunition.—*Q.* What are the parts of the ball cartridge? *A.* Cartridge case, primer, powder, bullet.

Q. What is the purpose of the primer? *A*. To ignite the smokeless powder.

Q. Describe the bullet for ball cartridge. *A*. It has a core of lead and tin composition inclosed in a jacket of cupro-nickel. The point is very sharp so as to offer little resistance to the air.

Q. Describe the bullet for the dummy cartridge. *A*. The bullet is similar to the bullet for the ball cartridge. To distinguish it from the ball cartridge, the dummy cartridge has a tinned case provided with six long straight grooves along it and three holes through it.

Q. Describe the guard cartridge. *A*. The guard cartridge is distinguished from the ball cartridge by having 5 grooves around the case (old style) or six short straight grooves at the shoulder (new style).

Q. What other types of ammunition may be used for guard purposes? *A*. Gallery practice cartridge.

Q. What is the weight of the ball cartridge? *A*. About an ounce; 100 rounds weigh about 5½ pounds.

Q. What types of service ammunition are used with the M1 rifle? *A*.

(1) Ball M2 and M1906.

(2) Tracer M1.

(3) Armor-piercing M1.

Q. What distinguishes armor-piercing and tracer ammunition from ball ammunition? *A*.

(1) Armor-piercing is painted black for ¼ inch from the point.

(2) Tracer is painted red for ¼ inch from the point.

Q. At what distance must personnel be from the M1 rifle when firing blank ammunition? *A*. Over 20 yards.

Q. What type of dummy cartridge may be used with the M1 rifle? *A*. The corrugated type of dummy cartridge (caliber .30, M1906) may be used for instructional purposes. *The use of the slotted type of dummy cartridge (range, caliber 0.30, M1) is prohibited.*

Q. What is the standard type of ball ammunition? *A*. Ball cartridge, caliber .30, M2, is standard.

124. U. S. caliber .45 automatic pistol, M1911 and M1911A1.—*a. Nomenclature and action.*—*Q*. What are the four main requirements for a military pistol? *A*. Accuracy within short ranges; power sufficient to stop an enemy instantly; rapidity of fire; and dependability.

Q. What models of the automatic pistol are used in the military service? *A*. Caliber .45 model of 1911 and model of 1911A1.

Q. What markings are on the pistol? *A*. On the right side, "Model of 1911 (or 1911A1), U. S. Army"; on the left side, "United States Property." All pistols are also marked with serial number.

Q. What is meant by caliber .45? *A*. Caliber .45 means that the distance between two directly opposite lands in the barrel, expressed in inches, is 45/100 of an inch.

Q. What are the lands and grooves? *A*. The lands are the raised portions of the bore and the grooves are the spaces between the lands.

Q. For what use is this pistol intended? *A*. For emergency use at short range.

Q. What is its effective range? Its maximum effective range? Its extreme range? *A*. Its ordinary effective range is 25 yards; its maximum effective range is placed at 75 yards; and its extreme range, if held at an angle of 30°, is about 1,600 yards.

Q. What is the muzzle velocity of the pistol, and what penetration is obtained? *A*. It has a muzzle velocity of 800 feet per second. A penetration of 1 inch in white pine corresponds to a dangerous wound. At a range of 25 yards this pistol will drive a bullet 6 inches into white pine.

Q. How many shots can be fired without reloading? *A*. Seven.

Q. How fast can it be fired? *A*. Starting with the pistol unloaded, it has been fired 21 times in 12 seconds.

Q. Which direction of twist do the lands and grooves in the bore give the bullet? *A*. A left twist, or counterclockwise as seen from the breech.

Q. How does this affect the bullet? *A*. The rotation keeps the bullet from tumbling in its flight, but also causes it to drift slightly to the left.

Q. In firing, should any allowance be made for this drift? *A*. No. At the short ranges at which the pistol is used the drift is so small that it is negligible.

Q. Name the three principal parts of the pistol. *A*. Receiver, barrel, and slide.

Q. Point out the following parts:

Receiver.	Rear sight.	Barrel bushing.
Extractor.	Disconnector.	Magazine.
Barrel.	Front sight.	Recoil spring.
Ejector.	Trigger.	Magazine spring.
Slide.	Link.	Recoil spring guide.
Firing pin.	Grip safety.	
Slide stop.	Link pin.	Magazine catch.
Hammer.	Safety lock.	Plug.

A. See figure 180 or 181.

Q. Why is this pistol called the automatic pistol? *A*. Because on being fired, the work of opening the breech, cocking the hammer, extracting and ejecting the empty shell, and forcing a new cartridge into the chamber, is done automatically by the force of recoil.

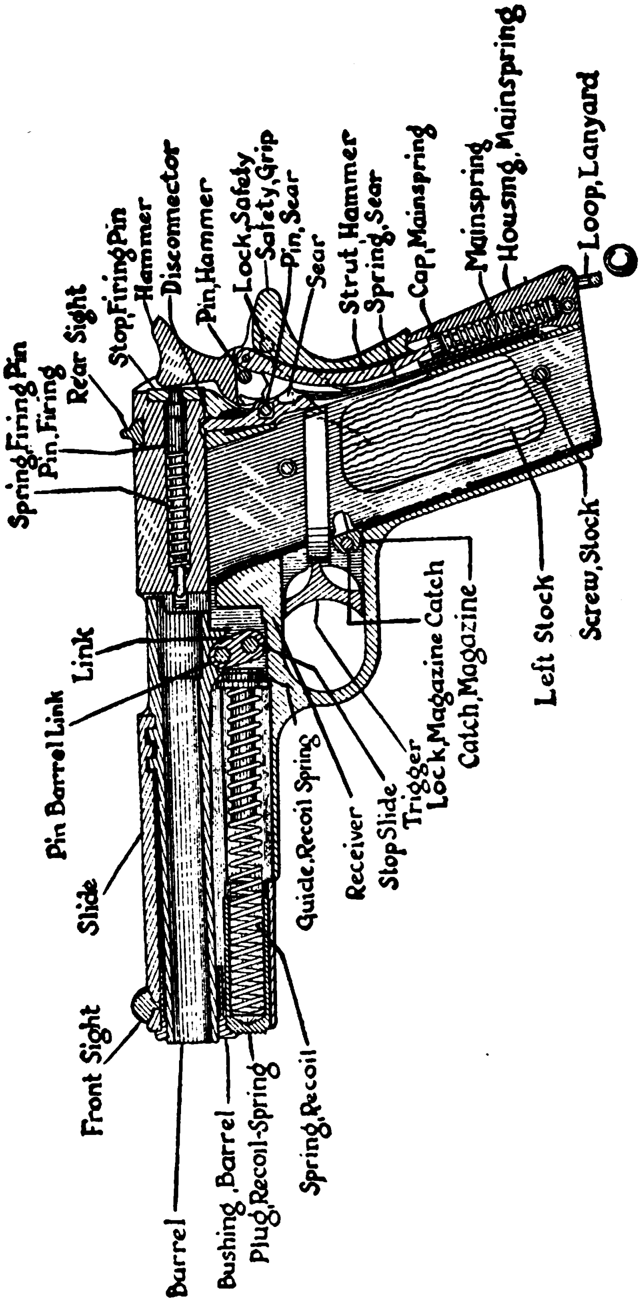


FIGURE 180. Automatic pistol, M1911.

Q. Describe briefly the functioning of the pistol. *A*. The force of the explosion causes the barrel to recoil slightly. It moves rearward and down until it is stopped by the lug holding link. The slide, having been unlocked from the barrel, moves to the rear extracting and ejecting the old shell, compressing the recoil spring, and

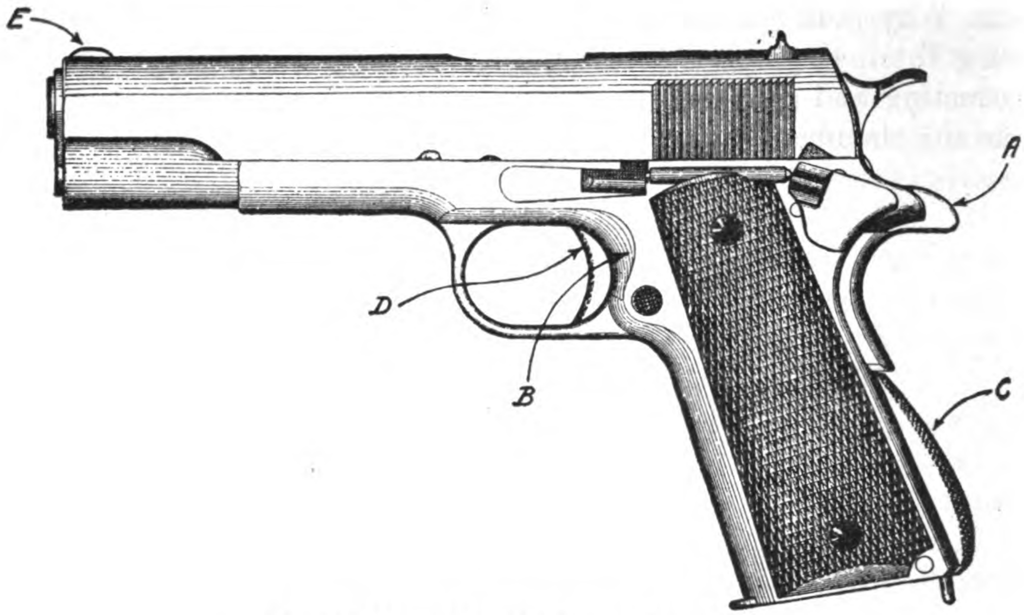


FIGURE 181.—Automatic pistol, M1911A1.

NOTE.—Modifications over the M1911 automatic pistol are shown and indicated by letters A, B, C, D, and E.

cocking the hammer. The greatly compressed recoil spring then forces the slide to the forward position. During this movement the slide pushes the new bullet, which has been raised into the chamber by the action of the magazine follower into the barrel, and pushes the barrel forward slightly and up, locking into the locking ribs ready for firing again.

Q. How is the pistol loaded? *A*. A loaded magazine is placed in the stock and the slide drawn fully back and released, thus bringing the first cartridge into the chamber. The hammer is thus cocked and the pistol is ready for firing.

Q. How is the pistol fired? *A*. The trigger is pulled, releasing the hammer which falls and strikes the firing pin, driving the latter forward against the percussion primer. This primer ignites the powder which propels the bullet.

Q. How is the pistol loaded again? *A*. The loading is automatic as long as a cartridge remains in the magazine. On recoil the slide is driven to the rear and the recoil spring is compressed. The slide moves forward again, driven by the recoil spring, and another cartridge is carried into the chamber.

Q. What are the two automatic safety devices? *A*. The *disconnector*, which positively prevents the release of the hammer unless the slide and the barrel are in the forward position and safely interlocked; this device also controls the firing and prevents more than one shot from following each pull of the trigger. The *grip safety*.

which at all times locks the trigger unless the stock is firmly grasped and the grip safety pressed in.

Q. What other safety devices does the pistol have? *A*. The *safety lock*, by which the closed slide and the cocked hammer can be locked positively at will; the *half cock*, which prevents firing until the pistol is fully cocked.

Q. What is the purpose of the locking ribs on the barrel? *A*. To engage in the locking grooves in the slide, thereby securely locking slide to barrel in the firing position, and preventing it from rotating when the pistol is fired.

Q. What is the function of the link? *A*. To pivot the barrel, allowing it sufficient play to rise on its slight forward movement and lock into slide, and also to fall on its rearward movement and disengage from locking grooves, letting the slide continue its movement to the rear. It holds the barrel to its position in the receiver.

Q. What is the function of the magazine-follower lip? *A*. When the last bullet in the magazine has been fired, the shell is pushed up into chamber through the action of the magazine-follower spring. As the slide moves to the rear upon recoil, the lip engages the pawl on the slide stop and forces it up into slide-stop slot on the lower edge of slide, locking the latter in the rearward position. This serves to remind the firer that the last shot has been fired.

Q. What is the difference between the functioning of the extractor and the ejector? *A*. The extractor catches just in front of the shell rim and pulls it back out of the barrel when the slide moves to the rear after firing. The shell strikes against the ejector, which throws it out through the breech opening.

Q. How is the pistol disassembled for cleaning? *A*.

(1) Remove the magazine by pressing the magazine catch.

(2) Press the recoil spring plug inward and turn the barrel bushing to the right until the plug and the end of the recoil spring protrude from their seat, releasing the tension of the spring.

(3) Draw the slide to the rear until the smaller rear recess in its lower left edge stands above the projection on the thumb piece of the slide stop; press gently against the end of pin of the slide stop which protrudes from the right side of the receiver above the trigger guard, and remove the slide stop.

(4) This releases the barrel link, allowing the barrel, with the link and slide, to be drawn forward together from the receiver, carrying with them the barrel bushing, recoil spring, plug and recoil spring guide.

(5) Remove these parts from the slide by withdrawing the recoil spring guide from the rear of the recoil spring and drawing the plug and the recoil spring forward from the slide.

(6) Turn the barrel bushing to the left until it may be drawn forward from the slide.

(7) This releases the barrel which, with the link, may be drawn forward from the slide and by pushing out the link pin, the link is released from the barrel.

Q. How is the pistol assembled? *A*. Proceed in the reverse order. When replacing the slide and barrel on the receiver, care must be taken that the link is tilted forward as far as possible and that the link pin is in place.

Q. How should one grasp the pistol for firing? *A*. To take the grip, hold the pistol in the left hand and force the grip safety device down and back into the crotch formed by the thumb and forefinger of the right hand. The thumb is carried parallel with or slightly higher than the forefinger, it should never be lower. Close the three lower fingers on the stock firmly but not with too tight a grip. The muscles of the arm are held firm but not rigid.

Q. How should one hold the breath while firing? *A*. To hold the breath, draw into the lungs a deep breath, let out a little of the air and stop the rest by closing the throat. Do not hold the breath with the throat open or by muscular effort of the diaphragm.

Q. What should be the position of the body? *A*. The body is a little more than half faced to the left, the feet 12 to 18 inches apart, depending on the man, and the body is perfectly balanced when the pistol is held in the shooting position. The whole position should be natural and comfortable.

Q. How should one squeeze the trigger? *A*. The trigger is squeezed with a steady increase of pressure so as not to know when the hammer will fall. It is squeezed only when the sights are alined on the target.

Q. How should the sights and the bull's-eye appear when the pistol is fired? *A*. The front sight should appear vertically in the center of the rear sight with its top level with the top of the rear sight. The bull's-eye should appear to rest on the top of the front sight.

b. *Maintenance of pistol*.—Q. What causes the most damage to a pistol when it is not properly cared for? *A*. Water. If allowed to remain on the metal parts of a pistol it will form rust and the surface of the metal will become "pitted."

Q. How is a pistol protected from water? *A*. By removing all moisture from the metal parts and covering them with a coating of oil or grease.

Q. How is a pistol cleaned after daily drill? *A*. Rub the outside, including the stock, with a rag that has been slightly oiled, and then clean it with a perfectly dry rag. Swab the bore with an oily flannel patch and then with two or three perfectly dry ones. Dust out all screwheads and crevices with a small clean brush.

Immediately after cleaning, swab the bore with a flannel patch saturated with oil (or grease), finally drawing the patch smoothly through the bore and out of the chamber, allowing the cleaning rod to turn with the rifling. Wipe over all metal parts, including the mechanism and magazine, with an oily rag and put a few drops of sperm oil on all cams and working surfaces.

Q. Should a pistol be stored in a gun rack (or any other place) without a protective coating of oil? *A*. No. Even a perfectly clean and dry weapon will soon collect moisture which will damage the metal parts unless they are protected with oil or grease.

Q. Why should a pistol be cleaned after daily drill? *A*. Because handling the weapon removes oil and allows moisture from the hands to get on it.

Q. What tool may be used for tightening or loosening screws? *A*. Only a properly fitting screw driver. Never use a substitute because it will damage the screwheads.

Q. Should a pistol be cleaned before firing? *A*. Yes. Always wipe out the bore with a clean patch before going to the firing point. See that no dust, dirt, mud, snow, rags, patches, or other obstructions are in the bore before firing.

Q. What are the three main forms of the residue left in the bore after a pistol is fired? *A*.

(1) A coating of chemicals left by the burned powder.

(2) Particles of unburned or partially burned powder, called powder fouling.

(3) Particles of metal from the jacket of the bullet, called metal fouling.

Q. How do they damage a pistol if not removed? *A*. The chemicals attract moisture from the air which collects in the bore. The powder fouling and the metal fouling trap moisture underneath against the bore. The moisture causes rusting and pitting of the bore.

Q. How is a pistol cleaned after firing? *A*. The chemicals and powder fouling are dissolved by scrubbing the bore with a dissolving solution of hot water and issue soap or a sal soda solution. Hot water alone may also be used. (Cold water is used only when none of the other agents are available.)

Remove the barrel of the pistol and place the muzzle in a vessel containing the dissolving solution. Using a cleaning rod and a flannel patch inserted from the breech, pump the solution back and forth through the bore for about one minute. Next place a brass or bronze wire brush on the rod and run it through the bore all the way down and back three or four times, leaving the muzzle in the dissolving solution. A wire brush is necesssary to remove the powder fouling thoroughly. Next remove the brush from the rod and swab several more times with the dissolving solution. Then wipe the cleaning rod dry, remove the muzzle from the solution and, using dry clean flannel patches, thoroughly swab the bore until it is perfectly dry and clean. Also dry off the chamber and other metal parts thoroughly.

Finally, inspect the bore for metal fouling (see below). If no metal fouling is present, prepare the weapon for storage as you do after daily cleaning, and place it in the gun rack.

Q. How is the bore inspected for metal fouling? *A*. Hold the butt of the pistol pointed toward the sky and examine the bore from the muzzle, with the eye about 8 inches from the muzzle. If small smears, flakes, or lumps looking like dull lead are seen on the surface of the bore, this is metal fouling.

Q. What do you do in case you find metal fouling? *A*. Take the pistol to the supply sergeant and ask for instructions.

Q. How is metal fouling removed? *A*. It is removed with metal fouling solution which must be used only by qualified ordnance personnel.

Q. How soon after firing should a pistol be cleaned? *A*. When a pistol has been fired the bore should be cleaned thoroughly not later than the evening of the day on which it is fired. Thereafter it will be cleaned and oiled each day for at least the next three succeeding days.

Q. What oils can be used on pistols? *A*. Sperm oil for lubrication and medium rust-preventive compound for protection from rusting. No other oils should be used unless authorized by the battery commander or his representative.

Q. State some of the things one is prohibited from doing with a pistol. *A*.

(1) Except for the removal of those parts permitted for cleaning, a pistol will not be disassembled except by permission of a commissioned officer and then only under the supervision of a qualified person who knows the provisions contained in the ordnance pamphlet on the subject.

(2) Blued or browned parts of pistols must not be polished.
(3) All mutilations are prohibited.
(4) Nothing except the authorized oils may be used on a pistol.
(5) Weapons must be unloaded before being taken into barracks or tents.

c. Ammunition.—*Q.* What are the parts of the cartridge? *A.* Cartridge case, primer, powder, bullet.

Q. What is the purpose of the primer? *A.* To ignite smokeless powder.

Q. Of what does the bullet consist? *A.* A core of lead and tin composition inclosed in a jacket of cupro-nickel, weight 230 grains.

Q. What is the weight of the cartridge and bullet complete? *A.* About 3/4 oz.; 100 rounds weigh about 4½ lbs.

Q. How is ammunition packed? *A.* The cartridges are packed in pasteboard boxes containing 20 cartridges each. One hundred pasteboard boxes, or 2,000 cartridges are packed in one zinc case, hermetically sealed, with handle for tearing open. The whole is inclosed in a wooden chest, the cover of which is fastened with screw hooks and thumb nuts and sealed.

Q. What types of cartridges are provided for this pistol? *A.*
(1) Ball cartridge, caliber .45, M1911.
(2) Dummy cartridge, caliber .45, M1921.
The dummy cartridge case is tinned and has a 1/8-inch hole in the body.

Section II

NOMENCLATURE, ACTION, SERVICE, AND DRILL OF ANTIAIRCRAFT MACHINE GUN; ITS MOUNT, AMMUNITION, AND TARGETS

125. Nomenclature of gun and mount.—*a. Gun.*—*Q.* What is a machine gun? *A.* A weapon which fires small-arms ammunition automatically.

Q. What is the name of the machine gun in use in antiaircraft units which fires caliber .30 ammunition? *A.* Browning caliber .30 machine gun, M1917.

Q. Point out and state the uses of the important parts shown in figure 182. *A.* See figure 182.

Q. Point out and state the uses of the important parts shown in figure 183. *A*. See figure 183.

Q. Point out and state the uses of the important parts shown in figure 184. *A*. See figure 184.

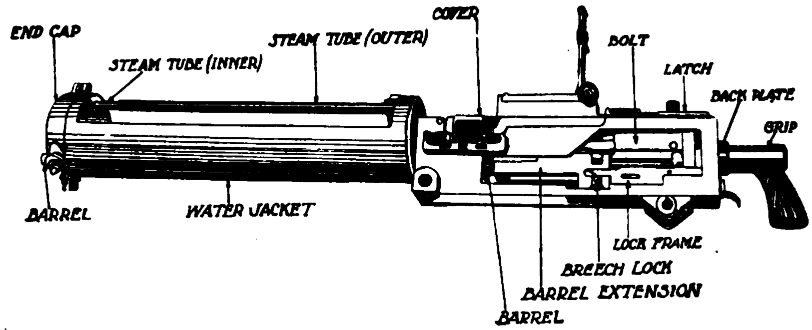


FIGURE 182.—Browning caliber .30 machine gun, M1917.

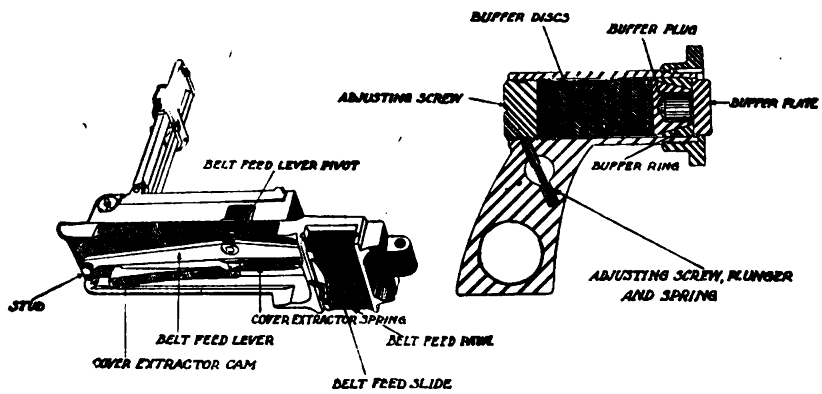


FIGURE 183.—Cover and backplate buffer groups.

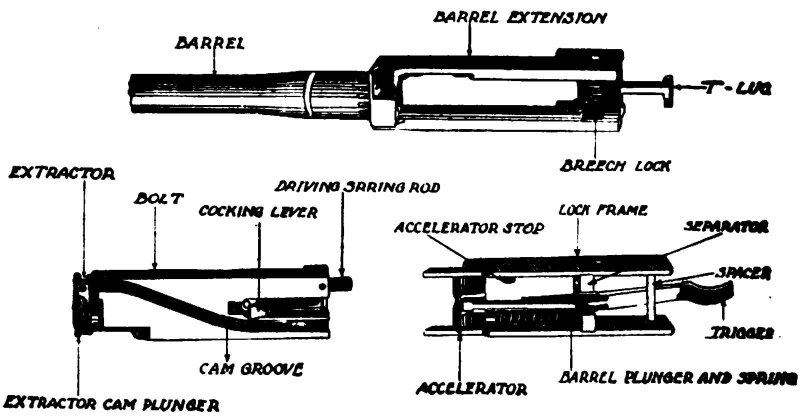


FIGURE 184. Barrel extension, bolt, and lock frame groups.

Q. What is the standard antiaircraft machine gun? *A*. The Browning caliber .50 machine gun M2.

Q. Compare the caliber .50 machine gun with the caliber .30 machine gun? *A*. Mechanically they are very similar. The main differences are—

(1) The caliber .50 gun has an oil buffer in place of the lock frame.

(2) The extractor feed cam, just back of the extractor cam, is pivoted, actuated by a spring, and called the switch in the caliber .50 gun.

(3) The caliber .50 gun has a water circulating system for cooling the gun while the caliber .30 gun depends on the water in the water jacket to cool the gun properly.

(4) The caliber .50 gun is provided with a sideplate trigger to permit the gun to be fired by depressing a lever on the M2 mount. The gun may also be fired by depressing the butterfly trigger in the backplate.

(5) The caliber .50 gun may be assembled to fire either with right-hand or left-hand feed.

Q. What are the rates of fire? *A*. Caliber .30, 400–525 shots per minute. Caliber .50, 400–650 shots per minute. These are the rates for a short burst of continuous fire. The usable rates for sustained fire consisting of a series of bursts will be much lower.

Q. Describe the sights with which the guns in your organization are equipped. *A*. ———.

b. *Mount*.—*Q*. What is the present standard antiaircraft machine-gun mount? *A*. The M2 pedestal mount.

Q. Is this mount used for both caliber .30 and caliber .50 machine gun? *A*. Yes. However, a special subcradle or adapter must be used for the caliber .30 gun.

Q. What other mount is sometimes employed for both caliber .30 and caliber .50 machine guns? *A*. The M1 tripod mount.

Q. What means is provided to help the gunner steady the gun for antiaircraft fire? *A*. A back rest or shoulder stock. The back rest is preferable.

126. Action of gun and mount.—*Q*. Describe antiaircraft machine guns as to their operation, ammunition feed, and cooling. *A*. They are recoil-operated, belt fed, and water-cooled.

Q. What does the belt feed mechanism do? *A*. As soon as a cartridge is withdrawn, it feeds the belt forward one loop and puts the next cartridge in place to be withdrawn.

Q. What does the extractor do? *A*. As the bolt comes back the extractor pulls a cartridge out of the belt and drops it into the T-slot in the face of the breech, the ejector on the end of the extractor having knocked the empty case out of the T-slot ahead of the full cartridge. As the bolt goes forward the extractor rises to grip the next cartridge in the belt while the bolt pushes the preceding one into the chamber.

Q. What is the purpose of the breech locking mechanism? *A*. To keep the breech closed tightly after the shot is fired until it is safe to open it.

Q. How is this done? *A*. By means of the breech lock, which locks the bolt to the barrel extension and does not release it until the barrel and bolt assembly have recoiled together a short distance.

Q. What are the main parts of the firing mechanism? *A*. The trigger, sear, sear slide (cal. .50), sear spring, firing pin and extension, and cocking lever.

Q. How does the firing mechanism work? *A*. When the trigger is operated, the sear is tripped allowing the firing pin to go forward and strike the rear end of the cartridge, firing the gun. Actuated by the shock of firing, the bolt moves to the rear, recocking the gun. If the gunner continues to hold the trigger in the firing position, the gun will fire automatically each time the bolt returns to its forward position.

Q. What is the purpose of the buffer mechanism? *A*. To cushion the blow of the bolt when it is stopped at the end of its recoil.

Q. What are the main parts of the buffer mechanism of the caliber .30 machine gun? *A*. Grip, buffer plate, buffer ring (which is split on one side), a number of fiber washers (buffer disks), and the adjusting screw. The caliber .50 mechanism is similar.

Q. What other shock-absorbing device is there in the caliber .50 gun? *A*. The oil buffer, which corresponds to the lock frame in the caliber .30 gun.

Q. What is its purpose? *A*. To cushion the shock of the recoil of the barrel and bolt assembly before the bolt is unlocked and opened. It is necessary on the caliber .50 gun because of its high power and heavy recoil.

Q. How can the rate of continuous fire of the caliber .50 gun be regulated? *A*. By inserting a screw driver blade into the slot in the rear of the oil buffer tube. Turn the tube clockwise to reduce the rate of fire, and counterclockwise to increase the rate of fire.

NOTE.—The continuous rate of fire of the caliber .30 machine gun may be increased by adding one or more buffer disks to the shock-absorbing group in the back plate grip.

Q. What is the purpose of the driving mechanism? *A*. To return the moving parts to the closed position after they have recoiled. The driving spring and the barrel plunger spring are compressed in recoil. As soon as the recoil ends, the springs push the parts back into the closed position again.

Q. Why is the cooling system necessary and important? *A.* Because the gun gets very hot if fired continuously. It would be damaged badly if there were no way to cool the barrel. Proper cooling of the gun is also required to reduce erosion of the bore to a minimum. Consequently it is very important to keep enough water in the water jacket.

Q. How can steam escape from the water jacket when the water gets hot? *A.* The inner steam escape tube runs lengthwise at the top of the water jacket and has a hole at each end. It has an outer tube sliding freely on it just short enough to uncover one of the end steam holes at a time. If the gun is elevated the outer tube slides back and covers the rear hole, preventing the water from running out, but uncovering the front hole and allowing the steam to escape.

127. Service of gun and mount.—*a. Gun.*—*Q.* What is head space? *A.* The distance from the face of the bolt to the base of the cartridge when the latter is fully seated in the chamber.

Q. What is the purpose of head space adjustment? *A.* To obtain the proper distance between the forward part of the bolt and the rear end of the barrel. This distance is not the actual head space.

Q. How is the head space adjustment made? *A.* It is made without removing the working parts of the machine gun from the casing. To head space the caliber .50, M2 gun, screw barrel by hand into barrel extension until it comes in contact with the bolt. Check to make sure that the end of the barrel extends through the barrel extension. Then unscrew the barrel two notches. If the gun operates sluggishly, unscrew the barrel one additional notch.

Q. What happens if head space is too small (adjustment too tight)? *A.* The breech lock will not fully enter its recess in the bolt. The gun operates sluggishly, and the barrel extension, bolt, or breech lock may become damaged.

Q. What happens if head space is too great? *A.* A separation of the cartridge case may occur. If there is any weakness in the head of the cartridge case, such as a split case, the possibility of a rupture is increased by excessive head space.

Q. How is the buffer mechanism in the backplate adjusted? *A.* By increasing or decreasing the number of fiber buffer disks in the grip. When the backplate is reassembled, the adjusting screw must be screwed tightly against the buffer disks.

Q. What is a stoppage? *A.* Any unintentional cessation of fire.

Q. What is immediate action? *A.* The procedure used for the prompt reduction of common stoppages.

Q. What are some possible stoppages? *A*.

(1) Misfire due to defective primer.

(2) Short round.

(3) Bulged round.

(4) Tight link or loop in belt.

(5) Thin rim, permitting nose of bullet to drop below chamber.

(6) Stretched or torn belt (fabric).

(7) Empty loop in belt.

(8) Ammunition improperly alined in belt.

(9) Battered or thick rim of cartridge.

(10) Failure to remove round from chamber.

(11) Set-back primer.

(12) Separated case which is removed from chamber by new round when bolt is pulled to rear.

(13) Separated case which stays in chamber when bolt is pulled to rear.

(14) Bullet loose in cartridge case. Cartridge case extracted from belt but bullet remains in belt.

(15) Short or broken firing pin.

(16) Weak or broken firing pin spring.

(17) Faulty engagement of firing pin and sear notch.

(18) Broken sear spring.

(19) Bent or worn belt feed lever.

(20) Belt feed pawl spring missing or weak.

(21) Belt feed pawl pin missing or out of position.

(22) Cover extractor spring missing or weak.

(23) Belt feed lever bent up (stud on lever jumps out of cam groove).

(24) Broken or damaged extractor.

(25) Belt holding pawl missing or spring weak.

(26) Broken or damaged ejector.

(27) Broken or damaged T-slot causing misalinement and buckling of cartridge as bolt moves forward.

(28) Weak ejector spring, causing misalinement and buckling of cartridge as bolt moves forward.

(29) Broken barrel extension.

(30) Defective trigger mechanism.

(31) Defective bolt switch.

(32) Bent or broken belt feed pawl arm.

(33) Cover not latched.

Q. Describe the procedure for immediate action. *A*.

Gun fails to fire

Pull the bolt to the rear, release it, and attempt to fire.

If the gun still fails to fire,

See if cover is latched, straighten ammunition belt, place hand to feel rounds entering feedway, and pull the bolt to the rear and release it.

If belt feeds,

attempt to fire.

If gun still fails to fire,

change bolt.

If belt does not feed,

raise the cover, remove the first round from the belt, and look or feel for a cartridge in the gun.

If a cartridge is

In the gun,

remove it,

reload, re-lay, and fire.

Not in the gun,

reload, re-lay, and fire.

NOTE.—If application of this procedure does not remedy the stoppage, the gunner must examine the feed mechanism and other parts of the gun in order to locate and remedy the trouble.

Q. Explain and demonstrate the removal and replacement of the groups of the caliber .30 machine gun. *A*.

(1) *Removing groups.*—(*a*) *Backplate.*—Pull back on latch and raise cover. With the left hand pull back the bolt handle and hold it in the rearmost position. Insert the rim of a cartridge in the slot in the rear of the driving spring rod. With the slot horizontal, push in the driving spring rod as far as it will go and turn it clockwise one-quarter turn until the slot is vertical so that the lugs on it will engage in the undercut recesses in the bolt. Then push the bolt handle forward about an inch to free the rear end of the driving spring rod from the backplate. Push the latch forward and lift out the backplate.

(*b*) *Bolt.*—Pull the bolt all the way back and remove the bolt handle. Then pull the bolt out of the rear end of the receiver.

(*c*) *Lock frame.*—Push in on the trigger pin through hole on the right side of the receiver with the point of a bullet or the combination tool. Pull lock frame, barrel extension, and barrel out through the rear of the gun until the lower rear lugs on the barrel extension are clear of the casing. Hold the lock frame firmly and push forward on the accelerator with the thumbs. This separates the lock frame from the barrel extension.

(*d*) *Barrel extension and barrel.*—Pull the barrel extension and barrel out to the rear. Unscrew the barrel extension from the barrel.

(*e*) *Cover.*—Remove latch and latch spring. Turn cover pin spring up. Draw the assembled pin out to the right of the casing. Remove the cover.

(2) *Replacing groups.*—The groups are replaced in the reverse order to their removal.

Q. Explain and demonstrate the procedure of removal and replacement of the groups of the caliber .50 machine gun. *A.*

(1) *Removing groups.*—(*a*) Release cover latch and raise cover.

(*b*) *Cover.*—The cover may be removed or left assembled to the gun as desired. To remove the cover, withdraw the cotter pin from the cover pin and pull out the cover pin.

(*c*) *Backplate.*—Release the backplate latch lock and latch and lift out the backplate.

(*d*) *Bolt.*—Press forward and away from the side plate on the end of the driving spring rod to release the retaining pin in the head of the rod from the hole in the side plate. Draw the bolt to the rear until the bolt stud can be withdrawn through the opening in the right side of the receiver of the gun. Remove the complete bolt from the rear end of the casing.

(*e*) *Oil buffer, barrel extension, and barrel.*—Compress the oil buffer spring lock, using the point of a bullet or the drift on the combination tool inserted through the hole in the right side plate, and remove the oil buffer, barrel extension, and barrel assembly from the rear of the casing. Detach the oil-buffer group from the barrel extension by pressing the accelerator forward.

(2) *Replacing groups.*—The groups are replaced in the reverse order to their removal. Be sure the backplate latch lock is in the unlocked position while the backplate is being replaced.

Q. When replacing the bolt of either a caliber .30 or caliber .50 gun, what precaution must be taken? *A.* Have the cocking lever in the forward position.

Q. What points should be observed before firing? *A.* The gun should be inspected to see that all parts of it are clean, sound, oiled where necessary, adjusted and functioning properly, that there is no excessive play or friction, and no leakage. The water jacket should be filled. A sufficient supply of ammunition, oil, spare parts, and tools should be on hand, and all should be inspected to see that they are in good order.

Q. What points should be observed during firing or temporary cessation in firing? *A.* The piece should be constantly inspected

and kept cleaned, oiled, and adjusted. Leakage should be checked, and the sights and tripod should be kept firmly set. Worn or broken parts should be repaired or replaced. Keep belt in line with feed opening, replace empty belts, and watch the ammunition supply.

Q. What points should be observed after firing? *A*. Inspect the piece, clean, oil, test, and adjust all working parts, replacing any that are broken or defective. Renew packing if necessary. Empty and flush out the water jacket. Clean, repair, and refill ammunition belts. Check spare parts, replace any that are missing, and clean and oil them.

b. Mount.—*Q*. What precautions must be taken to protect the sight mechanism of the M2 mount? *A*. When central control is used, care must be taken that the cover of the gun is not raised while the sight mechanism is being operated. At the conclusion of drill or action, if the guns and mounts are to remain in position, run the elevating screw of the front sight mechanism down as far as possible to protect it against possible injury. When movements are made from one emplacement to another, remove the sight assembly from the mount and place it in the carrying case.

Q. In assembling the M2 mount, what precaution is taken while assembling the legs to the pedestal? *A*. The cover is placed over the top of the pedestal to exclude dirt and grit from the cradle seat.

Q. What parts of the M2 mount should never be tampered with by members of the machine-gun squad? *A*. The recoil mechanism and the trigger control mechanism.

128. Drill of machine-gun squad.—*Q*. What personnel is provided by Tables of Organization for each machine gun assigned to seacoast artillery units? *A*. Three privates.

Q. How are they designated? *A*. Gunner (No. 1), assistant gunner (No. 2), and water chest operator (No. 3). When caliber .30 machine guns are employed, No. 3 acts as ammunition detail.

Q. How is the caliber .30 gun loaded? *A*. At the command LOAD, No. 1 advances his right hand opposite the belt exit and holds it in position ready to grasp the brass tag of the belt. No. 2 opens the ammunition chest, holds the brass tag at the point where it joins the fabric, and pushes the tag through the feed opening as far as possible. No. 1 grasps the tag as it is pushed from the belt exit and gives it a quick jerk to the right. He next pulls the bolt handle well to the rear and releases it. He again pulls the bolt handle to the rear and releases it. The gun is now loaded for automatic fire. The caliber .50 gun is loaded similarly. However, it should be

noted that the link belt used with the caliber .50 gun is not provided with a brass tag.

NOTE.—Each time the bolt handle is pulled to the rear, it should be released while in its rearmost position so as to give the driving spring full play in driving the bolt forward. If this is not done, the bolt may not go all the way forward, thereby causing a stoppage.

Q. How is the piece fired? *A*. The gun being mounted and loaded, at the command or signal COMMENCE FIRING, No. 2 taps No. 1 lightly on the back and calls: FIRE. No. 1 instantly pulls the trigger and continues to pull the trigger until CEASE FIRING is given. He must not disturb the aim or hold while doing so. The eyes must be directly on the target and any tendency to look down at the trigger must be avoided. No. 2 changes the ammunition boxes on the mount when necessary and assists No. 1 in clearing stoppages when they occur. No. 3 operates the water chest, beginning to turn the handle as soon as fire is commenced and continuing to turn the handle for about twenty turns after firing is stopped. When the caliber .30 gun is employed, No. 3 acts as ammunition detail and assists No. 2 in refilling the water jacket when necessary.

Q. How is the gun unloaded? *A*. At the command UNLOAD, No. 1 raises the sight leaf with the left hand, if it is lowered, after which he unlatches and raises the cover with the left hand. As soon as No. 1 has raised the cover sufficiently, No. 2 raises the extractor, withdraws the belt, packs it carefully in the ammunition chest, and closes the ammunition chest cover. As soon as No. 2 withdraws the belt, No. 1 lowers the extractor and the cover, pulls the bolt handle to its rearmost position, releases it, pulls the trigger, and lowers the sight leaf. No. 3 checks the water in the water chest (cal. .50 guns) or in the water jacket (cal. .30 guns). All members of the machine-gun squad assist in obtaining ammunition, refilling belts, and loading filled belts in ammunition boxes.

129. Ammunition and targets.—*Q*. With what safety precautions particularly applicable to machine guns in peacetime should every member of a machine-gun squad be familiar? *A*.

(1) Before removing the gun from the mount, unload the gun, raise the cover, and examine the chamber to be certain that the gun is empty.

(2) Load the gun only at the command of the officer conducting the firing.

(3) Allow no live ammunition near the emplacement except when firing is to take place.

(4) The covers on all machine guns will be partially raised and the guns unloaded except when the guns are firing or are about to fire.

(5) Always pass in rear of the gun in going from one side to the other.

(6) When tracking a target, the gunner will not touch the trigger until his sights are alined with the target and the field of fire has been indicated as safe.

(7) At the beginning of courses, machine guns must be kept depressed considerably below the elevation of the towing airplane until it has cleared the line of sight.

(8) When a stoppage is being cleared, the machine gun will be pointed at a safe part of the field of fire. This requirement will not prevent continued tracking of the target so long as the field of fire is safe.

(9) If malfunctioning of the gun causes it to fire continuously while the trigger is not being depressed, the firing can be halted by grasping the ammunition belt and twisting it with force so that the rounds cannot enter the feedway.

Q. What types of ammunition are used in antiaircraft machine guns? *A*. Ball ammunition and tracer ammunition of .30 and .50 calibers.

Q. What is the maximum range at which tracers are normally visible? *A*. Caliber .30 can be seen about 1,000 yards. Caliber .50 can be seen about 1,850 yards.

Q. What types of ammunition belts are used for machine guns? *A*. Caliber .30 machine guns are fed with fabric belts. Caliber .50 machine guns are fed with disintegrating link belts.

Section III

CORDAGE AND MECHANICAL MANEUVERS

130. Definitions.—*a. General.*—Rigging involves the technique of handling manila and wire rope and chains in various block and

tackle combinations to raise and move heavy loads. It is closely related to the handling of loads by jacks, levers, and similar mechanical devices.

b. Special terms.

Belay.—To make a turn or turns with a running end of rope around a spar, cleat, or the standing part of the rope.

Bight.—Loop formed on rope so that the two parts lie alongside each other or cross.

Frapping.—Drawing together of several turns by passing a rope around all the turns.

Mousing a hook.—Securing a load held in the hook by wrapping cord or twine across its mouth in such a way as to close it effectively.

Paying out.—Giving slack in rope.

Running end.—Free end of rope.

Seizing.—Lashing the running end back to the standing part.

Standing part.—Whole rope less the running end.

Thief.—Knot commonly mistaken for a reef knot, differing in that the end of each rope turns around the standing part instead of around the other rope.

Transom.—Horizontal spar.

Unlaying.—Untwisting of the strands or cords.

Upright.—Vertical spar.

Whipping.—Wrapping an end tightly with cord or twine to prevent its unlaying when pulled through a pulley or other small opening.

131. Characteristics of knots.

Name	Use	Directions for tying
Overhand	At end of rope to prevent unlaying or to prevent end from slipping through block.	See figure 185.
Figure-of-eight	Same as above	See figure 185.
Square or reef [1]	To join two ropes of same size.	See figure 185. Pass standing and running parts of each rope through loop of the other in the same direction. Ends of each rope turn around end of other, rather than standing part.
Single sheet bend or weavers.[2]	To join ropes, especially of unequal size.	See figure 185.

[1] Care must be taken not to tie a thief or granny, as these will slip.
[2] More secure than a reef but more difficult to untie.

Name	Use	Directions for tying
Double sheet bend [3]	To join ropes of unequal size, especially wet ones.	See figure 185.
Two half hitches [4]	To belay or make fast end of rope around own standing part.	See figure 185. End may be lashed down or seized to standing part to prevent slipping.
Round turn and two half hitches.	Same as above	See figure 185.
Fisherman's bend or anchor.	To fasten a rope to a ring or anchor.	See figure 185. Take two turns around the iron, then a half hitch around the standing part and between the ring and the turns, then half hitch around standing part.
Clove hitch	To fasten a rope at right angles to a spar or at beginning of lashing.	See figure 185. If end of spar is free, hitch made by first forming two loops, placing right hand loop over other, and slipping the double loop over the end of the spar. Other wise, pass end of rope around spar, bring it up to the right of standing part, cross over latter, make another turn around spar, bring up the end between spar last turn and standing part.
Timber hitch [5]	To haul or lift spar	See figure 186.
Telegraph hitch	To hoist or haul spar	See figure 186.
Hawser bend	To join two large cables.	See figure 186. Each end is seized to own standing part.
Bowline [6]	To form a loop that will not slip.	See figure 186. Make loop standing part underneath, pass end from below through loop, over the part, around the standing part, then down through the loop.
Bowline-on-a bight.	To make a comfortable sling for a man.	See figure 186. Make first part as above with double part of rope, then pull bight through sufficiently to allow it to be bent past loop and come up in proper position.

[3] More secure than a single sheet bend.
[4] Must not be used for hoisting a spar.
[5] Can be easily loosened when strain is taken off, but will not slip under load. When used for hauling spars, a half hitch is added near end of spar.
[6] Length of bight depends on purpose for which knot is required.

Name	Use	Directions for tying
Running bowline	To make a slip knot that will not bind.	See figure 186. Pass end around spar. Form a loop around the standing part with the running end. Make a bowline on the standing part below the loop on the running end side.
Cat's-paw	To secure a rope to the mouth of a hook.	See figure 187. Form two equal bights; take one in each hand and roll them along the standing part till surrounded by 3 turns of the standing part; then bring both loops (or bights) together and pass over the hook, and mouse the hook.
Sheep shank	To shorten a rope or pass a weak spot.	See figure 187. Take a half hitch with the standing parts around the bights.
Rolling hitch	To haul a larger rope or cable.	See figure 187. Take two turns around the large rope in the direction in which it is to be hauled, and one half hitch on the other side of the hauling part.
Blackwall hitch	To attach a single rope to a hook of a block for hoisting.	See figure 188.
Mooring knot	To make fast to a mooring or snubbing post.	See figure 188. Take 2 turns arround the mooring or snubbing post, pass the free end under the standing part, take a third turn above the other, pass the free end between the two upper turns.
Carrick bend	To fasten guys to derricks.	See figure 188.
Wall knot and crown on wall.	To furnish the end of a rope to prevent unlaying.	See figure 188.

132. Splices.—*Q.* What is the purpose of a short splice? *A.* Short splices are used to join two ropes when an increase in diameter at point of splice is not objectionable.

Q. How is a short splice made? *A.* Unlay the strands of each rope for a convenient length. Bring the rope ends together so that each strand of one rope lies between the two consecutive strands of

the other rope. Draw the strands of the first rope along the second and grasp with one hand. Then work a few strands of the second rope over the nearest strand of the first rope and under the second strand, working in a direction opposite to the twist of the rope. Apply the same operation to all strands. Splicing may be continued in the same manner to any extent, and the free ends may be cut off when desired. Splice may be tapered by cutting out a few fibers from each strand each time it is passed through the rope. Splice may be made compact by rolling under a board or under the foot.

Q. What is the purpose of a long splice? *A*. Long splices are used to join two ropes without an increase in diameter at point of splice.

Q. How is a long splice made? *A*. Unlay the rope and bring together as for a short splice. Unlay to a convenient length a strand (a) of one rope, laying in its place the nearest strand (d) of the other rope. Repeat the operation in the opposite direction with two other strands (c) and (f). Lay half of one in place of the unlayed half of the other. Pass the tops through the rope. When the splice has been thoroughly stretched, trim off the ends of the strands.

Q. What is the purpose of an eye splice? *A*. Eye splices are used for fastening a rope to a ring or for making a permanent loop in the end of a rope.

Q. How is an eye splice made? *A*. Unlay a convenient length of rope. Pass one loose strand under one strand of the rope, forming an eye of the proper size. Pass a second strand under the strand of the rope next to the strand which secures the first one. Pass the third strand under the one next to that which secures the second strand. Draw all taut, and continue as for a short splice.

133. Cordage.—*Q*. What is a cord rope? *A*. A rope made of vegetable fibers. These fibers are twisted together to form strands, and several strands are twisted together to form a rope.

Q. What is a wire rope? *A*. A rope of steel, or other metallic wire. A number of wires (usually 19) are twisted into strands and several (usually six) of these strands are laid around a hemp core.

Q. What is the purpose of the hemp core? *A*. To prevent the steel strands from rubbing against and cutting into each other, and to give flexibility to the rope.

Q. How is a rope designated as to size? *A*. By its circumference or diameter in inches.

Q. What are marline and seizing stuff? *A*. Marline and seizing stuff are both small-sized cordage. Marline is usually two stranded and laid up left-handed. Seizing stuff is made of better material and is usually three stranded, right-handed.

Q. How should cord rope be stored? *A.* In coils on skids or blocks so as to permit the circulation of air about the coil. Cord rope should never be stored wet.

Q. How is the strength of cord rope affected when slung over hooks or fastened by knots? *A.* The strength is lowered about one-third.

Q. What care should be used in uncoiling new rope? *A.* Care should be used to find the natural lay of the rope and relieve the twist.

Q. How can rope be identified as right- or left-handed? *A.* By comparing it with a right- or left-handed screw thread.

Q. How should rope be coiled? *A.* Rope should be coiled right- or left-handed according to whether it is right- or left-handed rope.

Q. How should rope be cared for while in storage? *A.* It should be taken out at least once each year, dried, stretched, and all weak spots cut out.

Q. What precaution should be taken before using old rope? *A.* It should be tested, especially when serious damage might result from its breakage.

Q. What should be done before cutting a rope? *A.* A whipping should be placed on each side of the spot where the rope is to be cut. The end of the rope should never be left free to unlay or ravel.

Q. Demonstrate a wall knot, figure-of-eight, bowline, anchor knot, bowline-on-a-bight, sheepshank, cat's-paw, square knot, rolling hitch, clove hitch, blackwall hitch, timber hitch, sheet bend. Explain the use of each. *A.* (Practical demonstration. Explain use as given in paragraph 131.)

Q. How is wire rope coiled? *A.* Small size wire rope may be coiled in the same manner as cord rope. Large wire rope should be coiled in a figure eight.

Q. What is the principal precaution to be taken in using a wire rope? *A.* Never let it become kinked while under a strain.

Q. Name the component parts of a clip. *A.* The roddle, the U-bolt, and the U-bolt nuts.

Q. How should wire rope be attached? *A.* Normally, wire rope should be attached with thimble and clips. The rope may be secured around the thimble by splicing, but this requires expert work. In the absence of clips a seizing of wire may be used.

Q. What precautions must be taken when using wire rope attached with thimble and clips? *A.* See that the roddles of all clips are in contact with the *long* end of the rope (fig. 196). After the wire rope has been subjected to strain the clip bolts must be tightened.

134. Blocks and tackle.—*Q*. What is a block? *A*. A block consists of a shell or frame of metal, or wood and metal, housing a grooved pulley or sheave on which rope runs, and giving support to the ends of a pin on which the sheave revolves. A hook, usually free to revolve (swivel), may be attached to one end of the block and often an eye or becket to the other end.

Q. What are the parts of a block? *A*. The parts of a block are the shell or frame, the sheave or wheel upon which the rope runs, and the pin upon which the wheel turns in the shell.

Q. How are blocks designated? *A*. Blocks are designated by the length of the shell in inches and by the number of sheaves. Those with one, two, three, or four sheaves are called single, double, triple, and quadruple. The smallest size of block (length in inches) that will take a given rope is nine times the rope diameter. Self-lubricating blocks should be used where obtainable.

Q. Define the following:

Chockablock.—When the blocks are in contact, the tackle is said to be chockablock.

Overhaul.—To overhaul is to separate the blocks.

Return.—Each part of the rope between the two blocks, or between either end and the block, is called a return.

Round in.—To round in is to bring the blocks closer together.

Running block.—A running block is a block that is attached to the object to be moved.

Simple tackle.—A simple tackle consists of one or more blocks rove with a single rope.

Snatch block.—A snatch block is a single block with the shell open at one side to admit a rope without passing the end through.

Standing block.—A standing block is a block that is fixed to some permanent object.

Q. What is the purpose of blocks? *A*. Blocks are used to change the direction of pull and to give mechanical advantage. A man of average weight will pull about 60 pounds horizontally.

Q. What is a tackle? What are the different parts? *A*. A tackle is a rope and block or a combination of ropes and blocks working together for use in lifting or moving objects. The standing part of a tackle is that part of the rope between the end which is made fast to one of the blocks, to the weight to be moved, or to some fixed point and the point where it passes over the first sheave. The running part of the rope consists of all the parts moving between the sheaves. The fall is that part of the rope to which the power is ap-

plied. A moving block is called a running block and a fixed block is called a standing block.

Q. What is meant by the power or mechanical advantage of a tackle? *A*. The ratio of the load to the power required to lift or move it. Thus, if a load of 600 pounds can just be lifted by a pull of 150 pounds, when a certain tackle combination is used, the power of the tackle is four.

Q. How is the mechanical advantage of tackle determined? *A*. It is determined by considering the number of ropes that support the load. Thus, when a double moveable block is used, four ropes support the load and the mechanical advantage is four.

Q. Draw sketches showing: A whip tackle; a whip on a whip: a runner; a gun tackle; a luff tackle; and show the power of each. *A*. See figure 197.

Q. Why is a runner a more powerful tackle than a whip? *A*. Because the pull is in the same direction as that in which the load is moved instead of in the opposite direction.

Q. Rig a whip tackle. Gun tackle. Luff tackle.

Q. What is a chain or triplex block? *A*. A chain or triplex block consists of a train of gears operated by a large wheel over which an endless chain passes. Power is applied to this chain. The gears operate a sprocket wheel over which runs a heavy chain, the links of which fit into the sprockets. The heavy chain lifts the weight and is provided with a hook for supporting the weight. Chain blocks are rated according to their lifting capacities and range by ½-ton changes 1 to 5 tons.

135. Slings.—*Q*. Of what are slings made? *A*. Slings are made of manila rope, wire rope, or chains. The most common is a manila sling made by splicing the two ends together.

Q. How is a sling used? *A*. To use a sling, pass it around the article to be lifted. Pass the bight formed by one end through the bight formed by the other and then over the lifting hook. If the sling is the same size as the lifting rope, it should make a minimum angle of 30° with the horizontal. At this angle the stress in each branch of the sling is equal to the stress in the lifting rope. If the angle is greater than 30° the load is limited by the strength of the lifting rope; if less than 30° by the strength of the sling.

Q. How do you make a barrel sling? *A*. To sling a barrel horizontally, make a bowline with a long bight. To sling a barrel vertically, make an overhand knot on top of the two parts of the rope; open out the knot and slip each half of it down the sides of the barrel; secure with a bowline.

136. Lashings.—*Q*. How should two spars be lashed at right angles? *A*. Make a clove hitch around the upright a few inches below the transom. Bring the lashing under the transom, up in front of it, horizontally behind the upright down in front of the transom, and back behind the upright at the level of the bottom of the transom and above the clove hitch. Keep the following turns outside the previous ones on one spar and inside on the other, not riding over the turns already made. Make four more turns. Make two frapping turns between the spars, around the lashing, and finish the lashing off either around one of the spars or any part of the lashing through which the rope can be passed. Do not make the final clove hitch around the spar on the side toward which the stress is to come, as it may jam and be difficult to remove. While tightening, beat the lashing with a handspike or pick handle. This is called a square lashing.

Q. How should two spars be lashed for a pair of shears? *A*. Lay the two spars alongside each other with the points below which the lashing is to be made resting on a skid. Make a clove hitch around one spar, and take the lashing loosely eight or nine turns about the two spars, above the clove hitches, without riding. Make two or more frapping turns between the spars, and finish the lashings off with a clove hitch above the turns on one of the spars. Open the butts of the spars and pass a sling over the fork. Hook or lash a block to this sling. Make fast fore and back guys with clove hitches to each spar just above the fork.

Q. How should three spars be lashed for a gin or tripod? *A*. Mark on each spar the location of the center of the lashing. Lay two of the spars parallel to each other with an interval a little greater than the diameter of a spar. Rest their tips on a skid and lay the third spar between them with its butt in the opposite direction so that the marks on the three spars will be in line. Make a clove hitch on one of the outer spars below the lashing and take eight or nine loose turns around the three. Take a couple of frapping turns between each pair of spars in succession and finish with a clove hitch on the central spar above the lashing. Pass a sling over the lashing and the tripod is ready for raising.

137. Gins and shears.—*Q*. Describe a gin. *A*. A gin is a tripod of poles or spars. The two outside poles are called legs and the third called the pry pole. A gin requires no guys.

Q. What is a gin used for? *A*. For lifting heavy weights vertically.

Q. Name the different parts of a garrison gin. *A.* Two legs, pry pole, bolt and clevis, windlass and ratchet, two handspikes, three shoes, two braces, and tackle.

Q. How much can be safely lifted with it? *A.* About 17,000 pounds.

Q. Explain briefly how a garrison gin is assembled and raised. *A.* The legs and pry pole are laid on the ground with the heads together and in position for assembling. The head is then assembled by putting the pin through the legs, pry pole, and clevis. The windlass is put in place and the braces are brought up and put in their places. The gin is raised, after assembly, by raising the head and bringing up the foot of the pry pole toward the feet of the two legs. (See fig. 195.)

Q. Describe the shears. *A.* Shears consist of two spars, of a size suitable for the weight to be raised, lashed together at the fork. A tackle is fastened to the lashing by a strap or otherwise, the hook is moused, and holdfasts are required.

Q. What are shears used for? *A.* Shears are used for lifting heavy weights to move them a short distance, as in loading or unloading a ship or railroad car.

Q. How are shears held in position after being raised? *A.* By means of guys. (Lines from the top of the shears to holdfasts on the ground.)

Q. How are the shears raised? *A.* If not too heavy, lift the head and haul in on the proper guys. If too heavy to raise in this way, form a crutch by lashing together two poles near their upper ends, the feet of the crutch being slightly in rear of the heels of the shears and secured to prevent them from slipping. Lay the rear guy over the crutch and raise the crutch by means of two light guy ropes, until it is inclined at an angle of about 45° to the front. Haul on the rear shear guy, allowing the crutch to rise as the shears rise. After the shears are raised high enough so that the crutch ceases to act, the crutch is lowered by means of its guy ropes. Footings should be prepared for heavy shears on hard ground, and the legs should be connected by a lashing to prevent spreading.

Q. How is a load moved horizontally by means of shears? *A.* By slacking off on one guy and taking up on the other. Tackle may be used for this purpose if necessary.

138. Anchorages.—*Q.* What is the purpose of an anchorage? *A.* It furnishes a holdfast for the tackles or guy cables in handling heavy loads by means of tackles, gins, shears, etc.

Q. Describe two forms of anchorages? *A*. The picket holdfast is a succession of pickets driven into the ground in continuation of the guy or cable and at right angles in a vertical plane to the line of pull. connected from the top of one picket to the bottom of the next, with the direct pull on the bottom of the first picket. A deadman is a log, rail, or other arrangement buried in the ground, horizontally at right angles to the line of pull, which is applied to the center of the deadman.

Q. What is the purpose of a holdfast? *A*. Holdfasts are used to anchor a line (for example, a guy) to the ground.

Q. How is a holdfast made? *A*. Drive stout pickets into the ground, one behind the other, in the line of pull. Secure the head of each picket, except the last, by a lashing to the one behind it. Tighten the lashings by rack sticks, and then drive the points of these into the ground to hold them in position. The distance between pickets should be several times the height of the picket above the ground. A single good ash picket, 3 inches in diameter, driven 5 feet into good solid earth, will stand a pull of about 700 pounds.

Q. What is the purpose of a deadman? *A*. A deadman has the same use as a holdfast. It has greater strength than a holdfast, but requires more labor to construct than a holdfast.

Q. How is a deadman prepared? *A*. Lay a log or timber in a transverse trench with an inclined trench intersecting it at its mid point. Pass the cable down the inclined trench, take several turns around the log, and fasten the cable to the log by half hitches and marline stopping. If the cable is to lead horizontally or incline downward, pass it over a log at the outlet to the inclined trench. If the cable is to lead upward, the log is not necessary, but the deadman must be buried deeper. The strength of the deadman depends upon the strength of the log and holding power of the earth.

Q. How can you determine the holding power of a deadman? *A*. For given cable pull, the number of square feet of deadman bearing surface required is determined by dividing the total pull to be placed on the deadman by the value given for the depth and cable inclination selected in Table LXVI, FM 5–10.

139. Jacks.—*Q*. Name two types of jacks. *A*. Screw jacks and hydraulic jacks.

Q. What the is usual maximum lift of a screw jack? *A*. Usually from 16 to 18 inches. Care should be taken that it is not screwed too high.

Q. What liquid is used for filling hydraulic jacks? *A*. A mixture of alcohol and water.

Q. How would you determine what mixture of fluid to put into a hydraulic jack? *A*. Consult the manufacturer's handbook or operational instructions.

Q. Can all hydraulic jacks be used in both the horizontal and vertical position? *A*. No. They are manufactured in two classes, horizontal jacks and base jacks. Horizontal jacks may be used in any position. Base jacks are used in the upright position. but may be inclined provided that the head is always kept higher than the base.

Q. How may the two classes of jacks be distinguished? *A*. They may be distinguished by the fact that the base jack has the pump and reservoir within the ram while the horizontal jack, which is the shorter one, has a separate piece for the cylinder which has no connection with the reservoir except through the pump and the lowering passage.

Q. How is the hydraulic jack filled? *A*. To fill the hydraulic jack start with the ram down. Remove the lowering valve and hexagonal cap. Fill through the large hole. Small amounts necessary to replace liquid which has leaked out may be put in by removing the small screw and filling.

Q. How is the hydraulic jack emptied? *A*. To empty, have the ram down, place the finger over the escape hole in the cylinder. pump the ram until the bottom of it is above the hole, then open the lowering valve and remove the finger from the escape hole allowing air to enter under the ram. The ram may now be lifted out. Remove the lowering valve and hexagonal cap and invert the jack to allow the liquid to run out.

Q. What general precautions should be taken in using the hydraulic jack? *A*. The ram should be kept down when not in actual use. In raising a weight the lever should be inserted in the socket with the projection down. The lowering valve should be closed. The lever should be worked up and down with a slow steady stroke. A weight is lowered by opening the lowering valve. The speed of lowering is controlled by the valve. It should be lowered slowly and never checked suddenly. The jack is designed to lift its rated load with one man operating the lever.

Q. What general precautions should be taken in using the screw jack? *A*. It must never be screwed out to the full extent in raising a weight. The threads must be kept clean, lubricated, and free from burs. The jack should not be used to lift weights greater than its rated capacity.

140. Blocks and wayplanks.—*Q*. What are the requriements of blocks? *A*. Blocks should be sound, free from knots, unpainted, and free from grease. Edges should not be splintered or rounded.

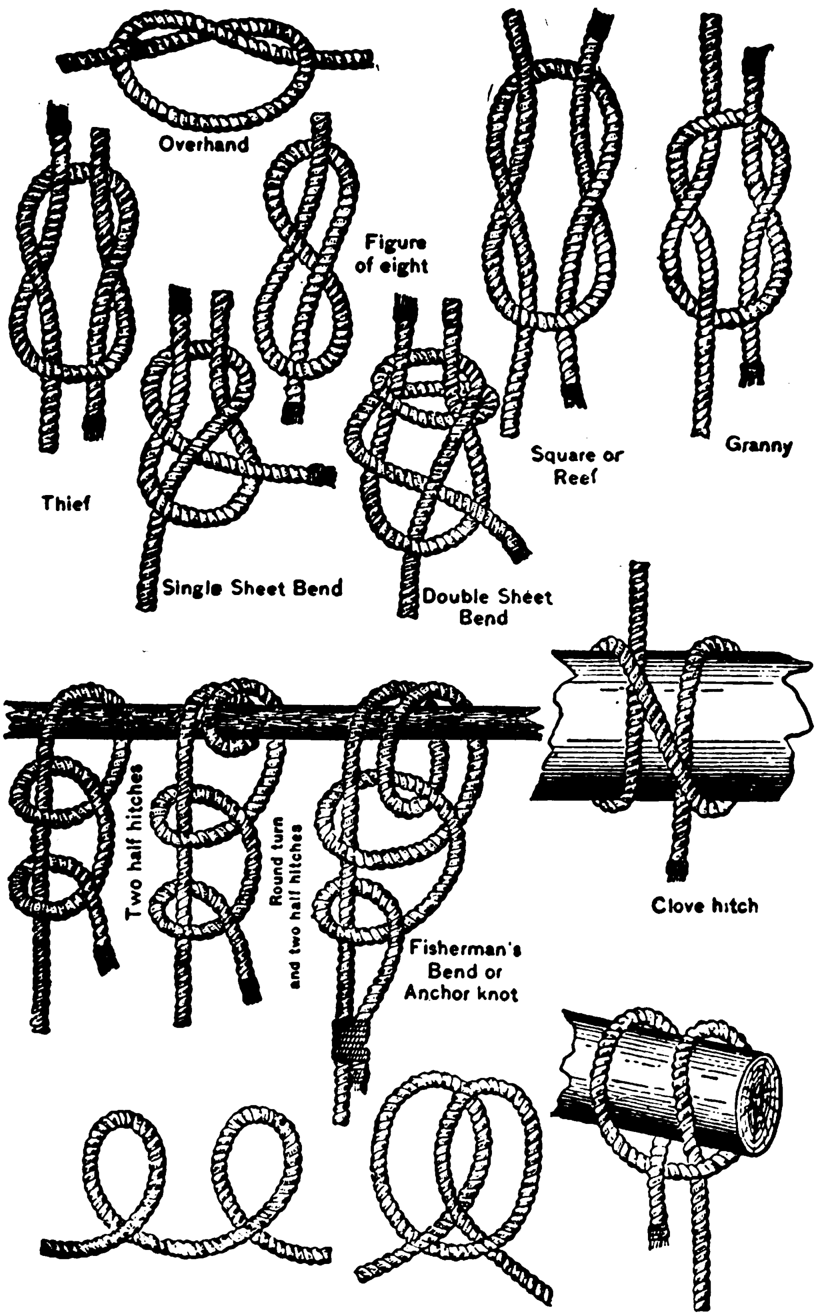


FIGURE 185.—Types of knots—hitches, bends, overhand, etc.

Q. What precautions should be used in erecting a crib? *A*.
(1) The foundation should be level.
(2) Large enough blocks should be selected.

(3) The blocks should then be laid crossing each other in alternate tiers, and the weights supported should be made to bear equally upon all sides of the base.

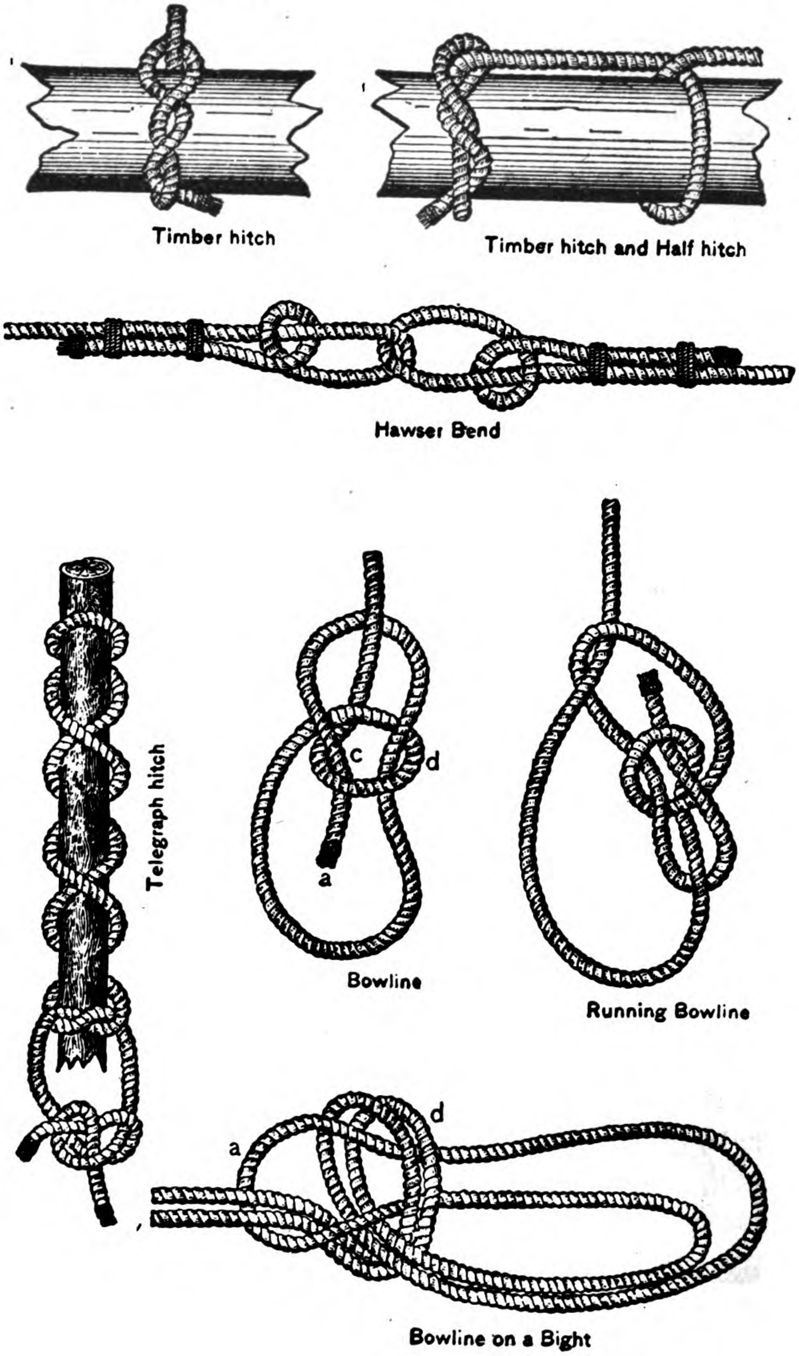


FIGURE 186.—Types of knots—hitches, bends, and bowlines.

Q. What is a wayplank and how is it used? *A*. A wayplank is a hard plank, preferably of oak, usually about 15 feet long, 12 inches wide, and 5 inches thick. Each end is beveled for a distance of

6 inches, the bevel on one end being on the side opposite the bevel on the other end. These planks are used chiefly for forming tem-

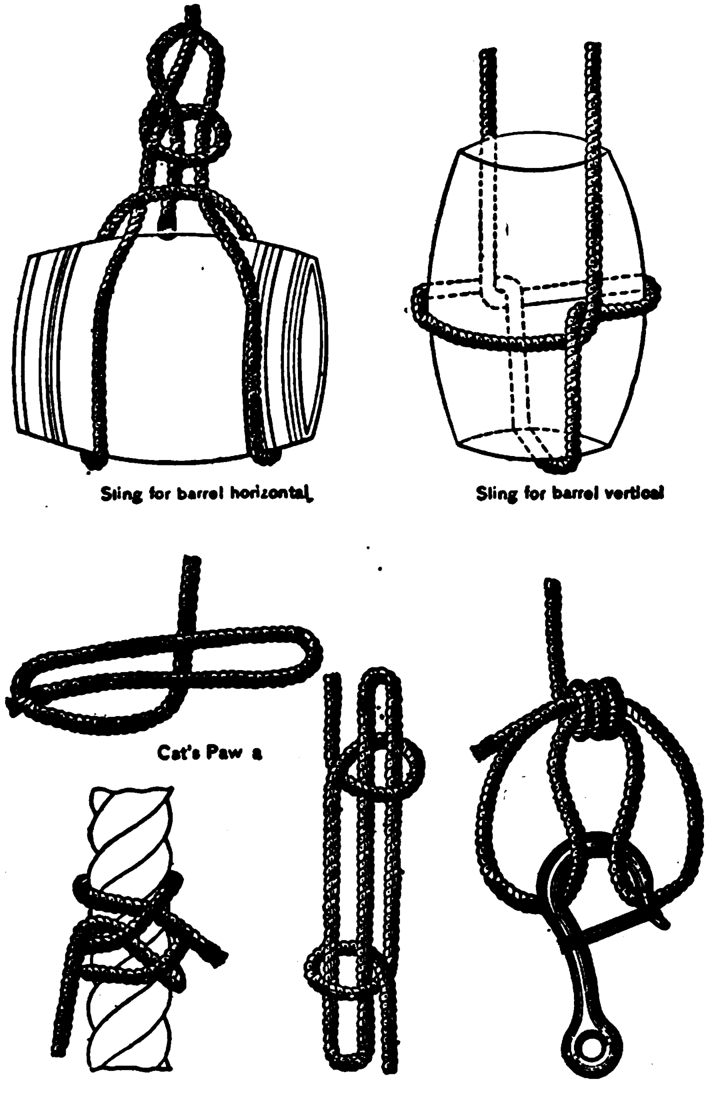


FIGURE 187.—Miscellaneous knots.

porary tramways for rollers, or for the wheels of carriages bearing heavy weights, especially in crossing weak bridges.

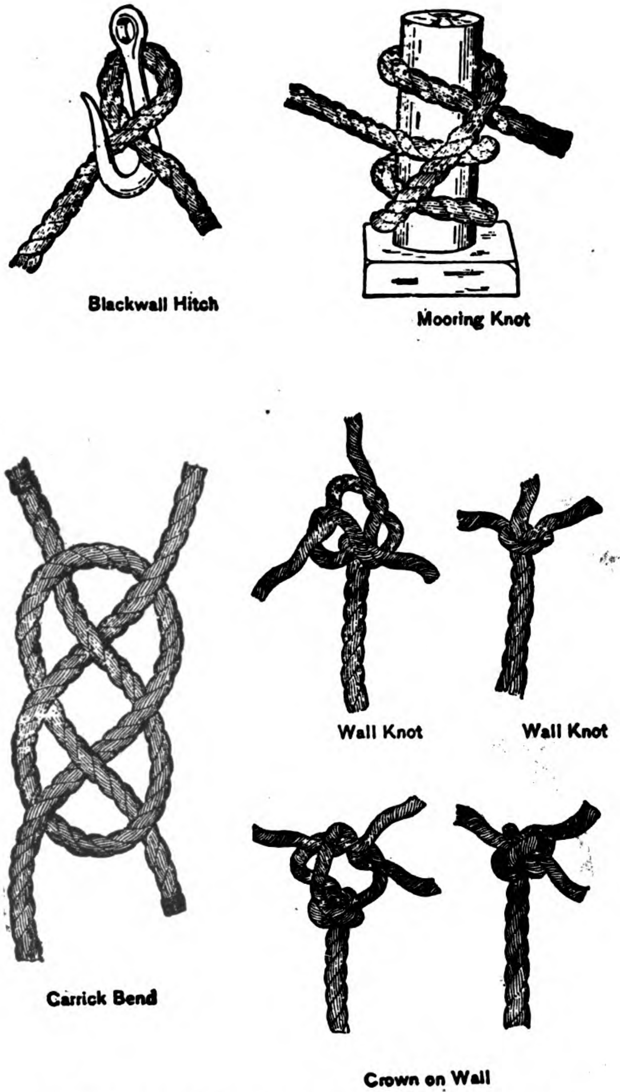


FIGURE 188.—Miscellaneous knots and hitches.

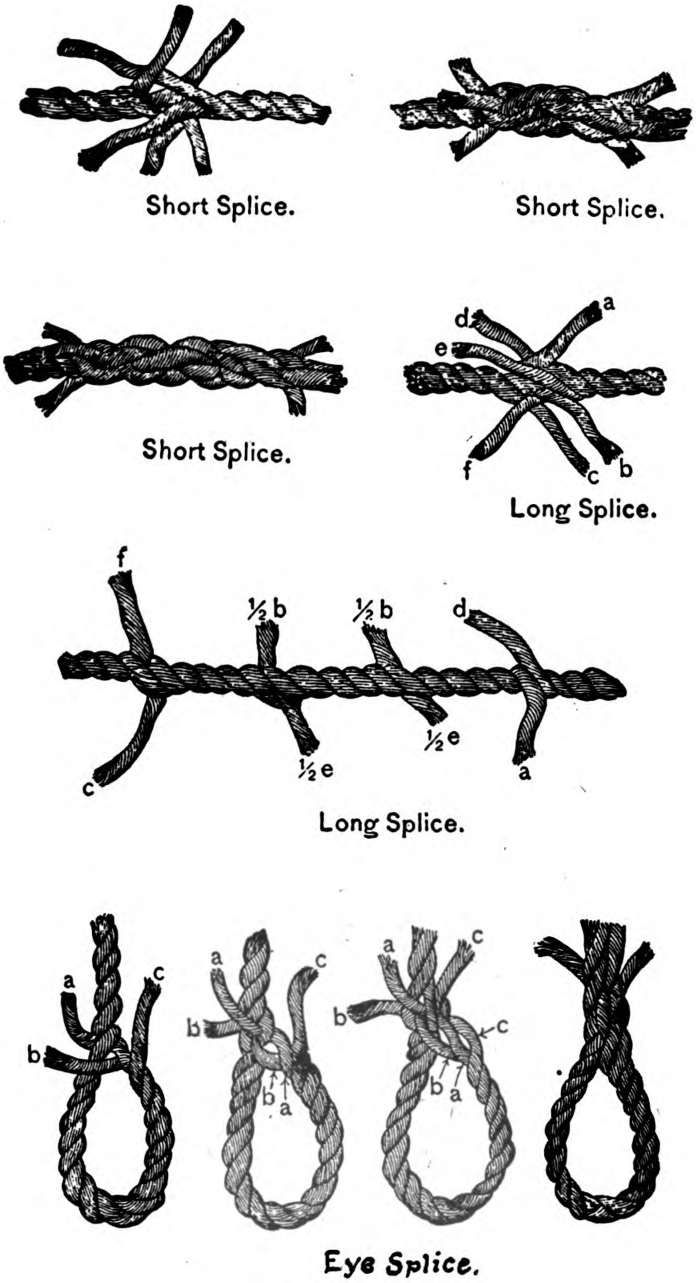


FIGURE 189.—Splices.

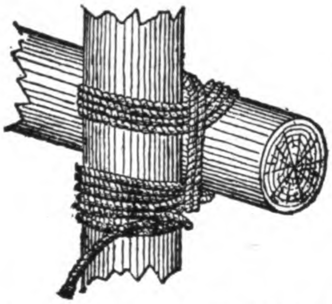


FIGURE 190.—Square lashing.

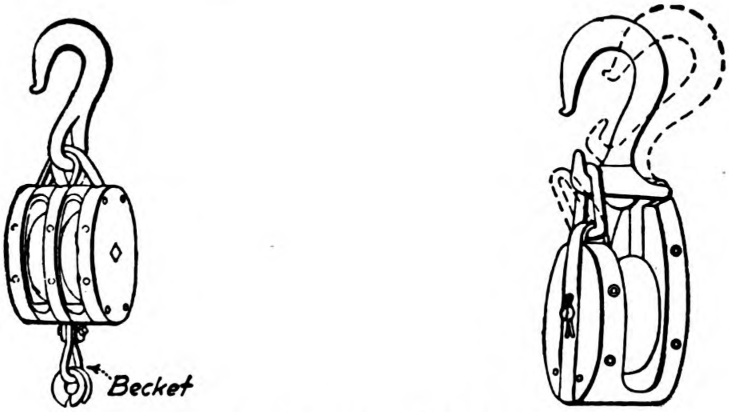


FIGURE 191.—Double wooden block and snatch block.

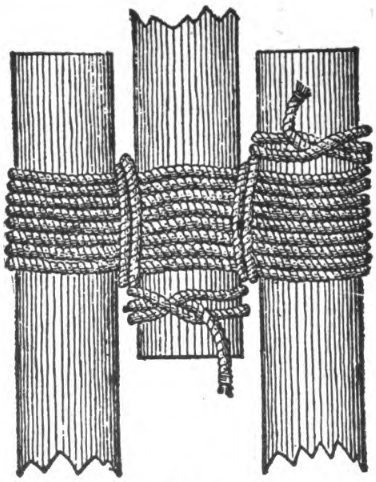
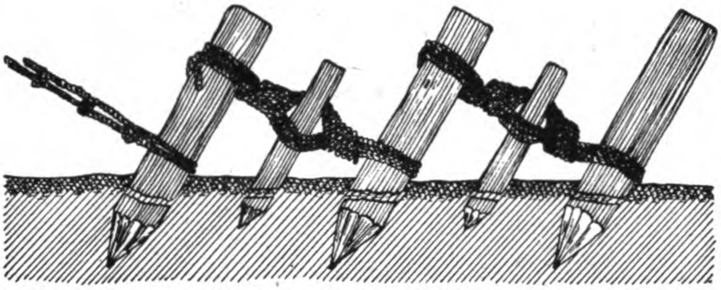
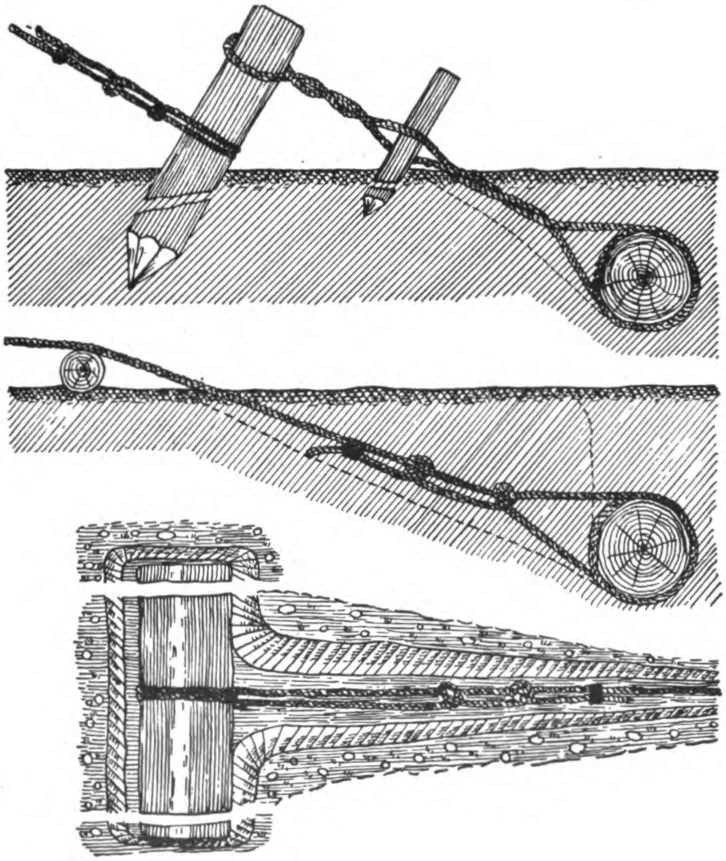


FIGURE 192.—Lashing for tripod.



Holdfasts.



Deadman.

FIGURE 193.—Anchorages.

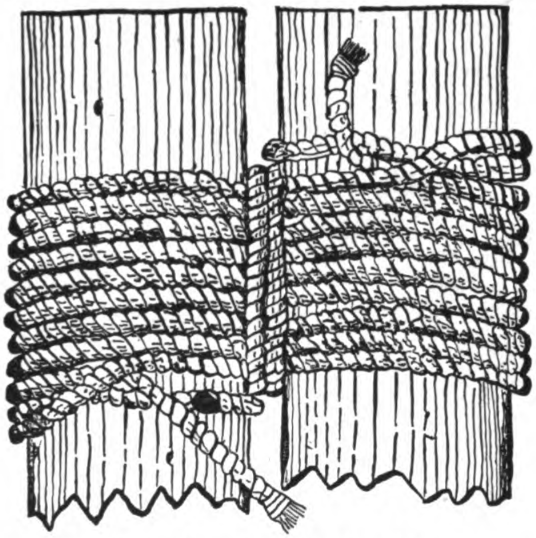


FIGURE 194.—Lashing for shears.

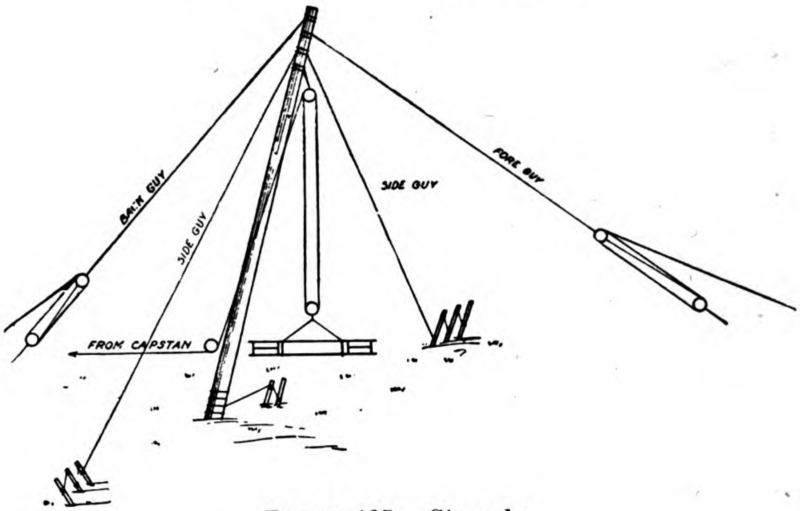


FIGURE 195.—Gin pole.

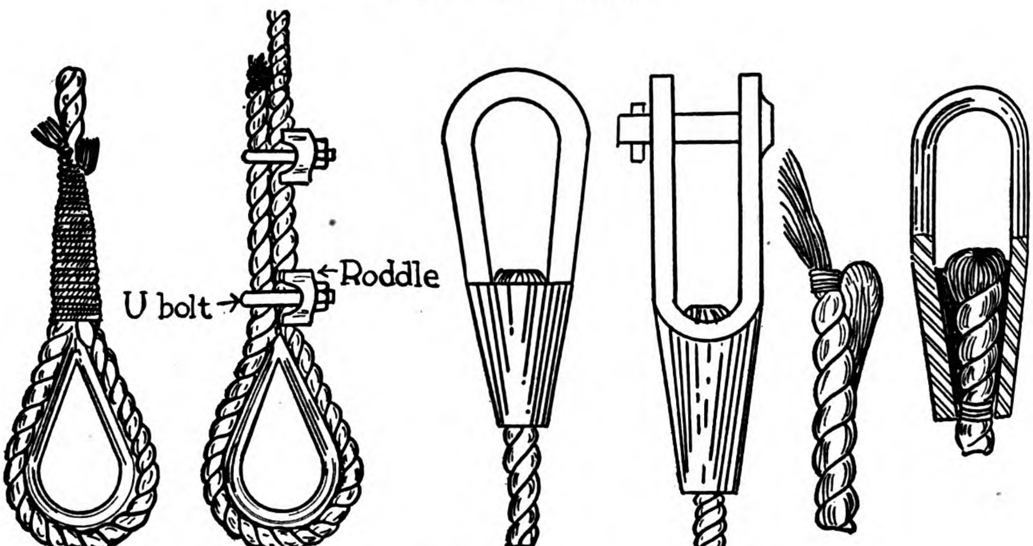


FIGURE 196.—Wire rope fittings.

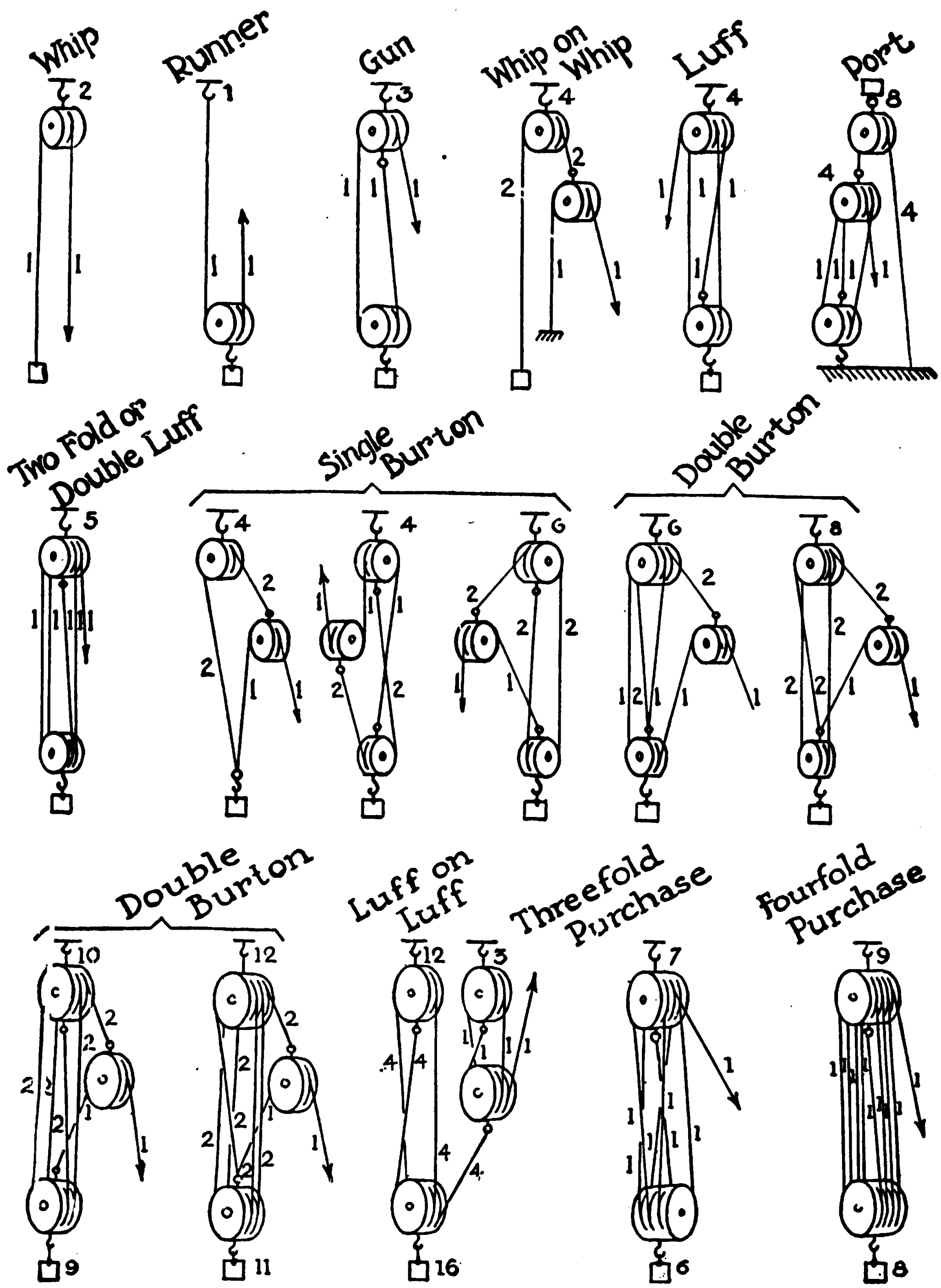


FIGURE 197.—Block and tackle combinations.

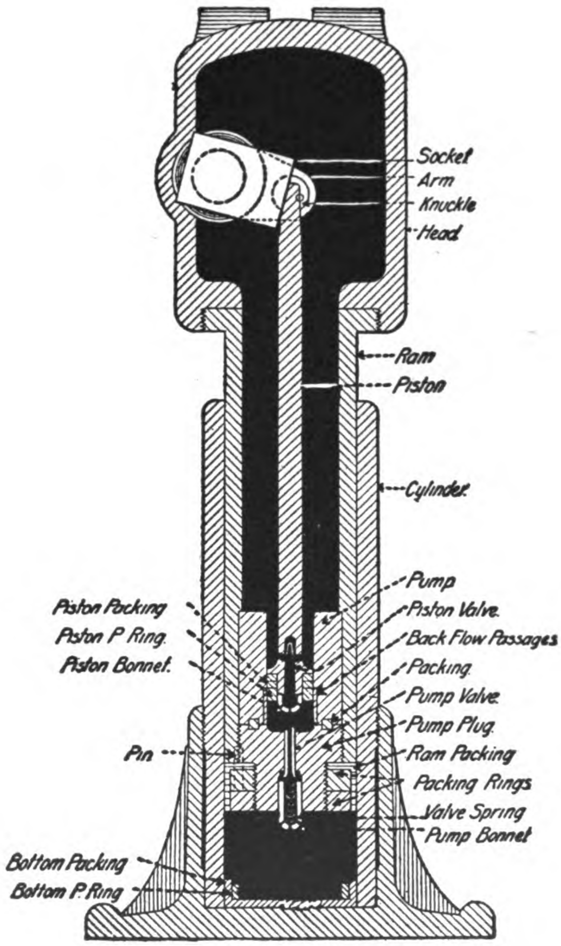


FIGURE 198.—Base jack.

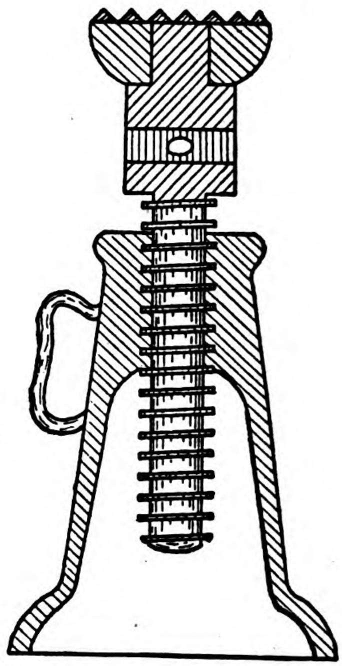


FIGURE 199.—Screw jack.

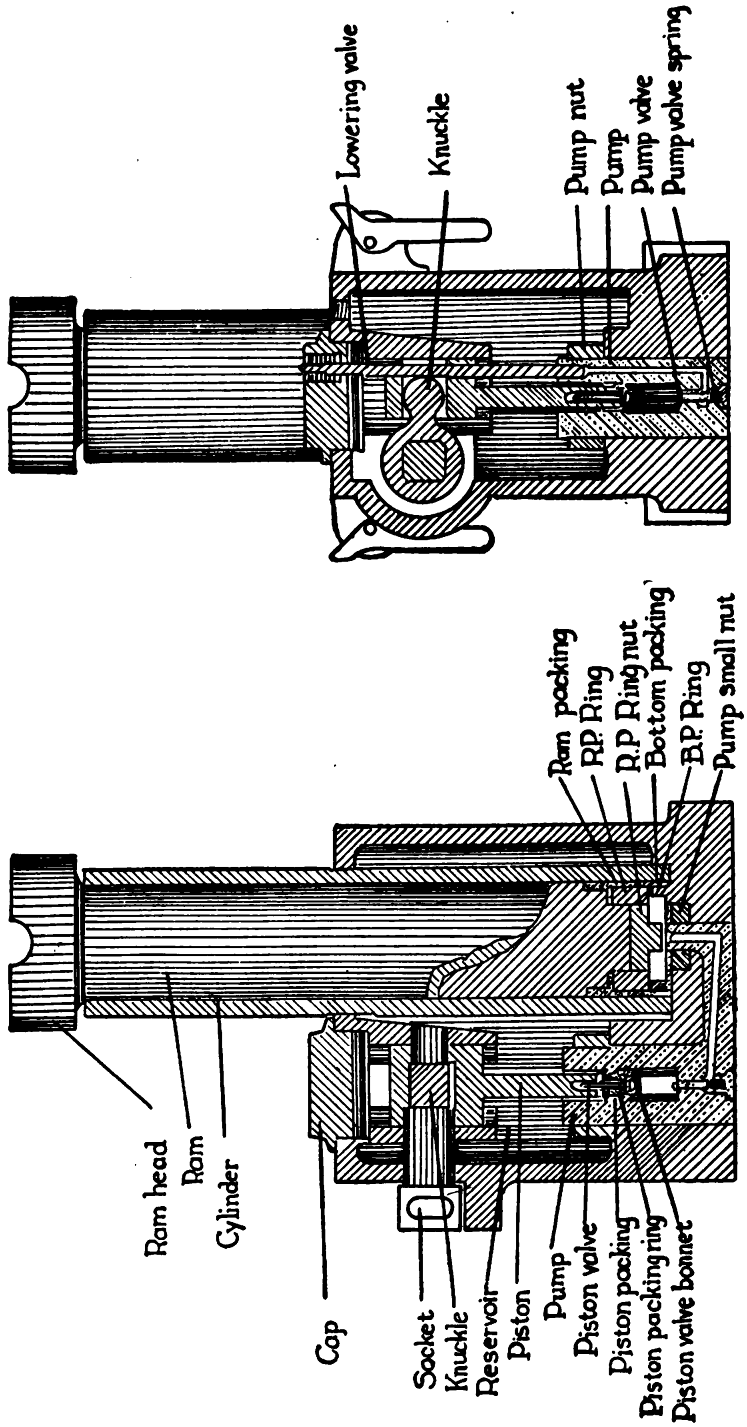


FIGURE 200.—Horizontal hydraulic jack.

SECTION IV

INDICATION, IDENTIFICATION, AND CHARACTERISTIC FEATURES OF WARSHIPS

141. Indication.—*Q*. How are naval targets indicated? *A*. By stating the subarea and the name (or type and class) of a single ship; or subarea type, formation, direction of movement, ship number and class, when target is one of a group of ships.

Q. How would one of a column of destroyers in water subarea "Rudy" be assigned as a target? *A*. 1. TARGET, 2. RUDY, 3. DESTROYER DIVISION IN COLUMN, 4. LEADING SHIP (observers, spotters, and gun pointers report on target), 5. TRACK.

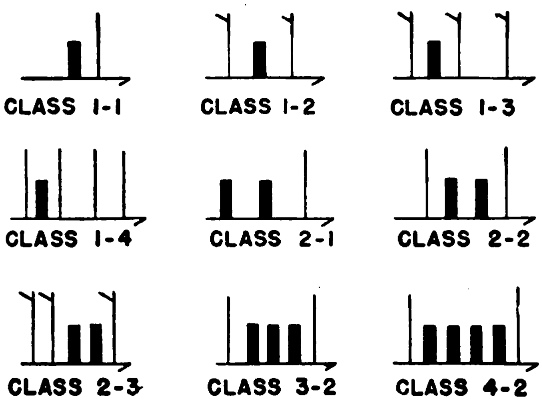


FIGURE 201.—Classification of ships.

Q. How are ships classified by the number of funnels and masts? *A*. By stating the number of funnels followed by the number of masts. Thus, a ship with three funnels and two masts would be designated as "Class 3-2."

142. Identification and characteristic features.—*Q*. How are warships classified? *A*. Warships are classified broadly as follows:

(1) *Capital ships*, mounting guns of a caliber exceeding 8 inches including battleships and battle cruisers.

(2) *Noncapital ships*, mounting guns 8 inches and smaller, including cruisers, destroyers, aircraft carriers, and submarines.

Q. What are the purpose and characteristic features of each type? *A*. (1) *Capital ships*.—(*a*) *Battleships* (BB) form the first line of battle. They are the most formidable type of war vessel and combine powerful weapons with the greatest protection possible. To carry the heavy guns and armor required to give maximum offensive and defensive power, speed has to be sacrificed to a certain extent.

Characteristic features of battleships are great size, moderate speed, heavy armor, large guns in turrets, massive appearance, low to medium freeboard, and broad beam. Their main batteries are of a caliber exceeding 8 inches and may include 16-inch guns with an effective range of 35,000 yards.

(*b*) *Battle cruisers* (CC) are similar in appearance to the battleships although their lines are finer. They carry the maximum caliber guns practicable, though fewer in number, and their armor protection is less than that of a battleship. This saving in weight is used to gain greater speed, permitting them to leave the battle line to gather information and yet be able to return in time to join the main action.

(*c*) *Pocket battleships* are lightly armored ships mounting guns of large caliber. They have greater fire power than cruisers. They are capable of greater speed than most battleships.

(*d*) Other capital ships include those provided for coast defense, carrying large caliber guns but having a very limited speed and cruising radius. Monitors are an example of this type.

(2) *Noncapital ships.*—(*a*) *Airplane carriers* (CV) are large ships of considerable displacement, moderate to high speed, some of them armored, armed with moderate sized guns, and carrying a large number of planes which are launched from and landed on specially constructed decks. The landing deck and the peculiar arrangement of the funnels and superstructure render these ships unmistakable. They are vulnerable to gunfire on account of their size and limited protection.

(*b*) *Cruisers* vary from fairly fast, heavily armed, moderately armored, large ships, to fast, lightly armed, unarmored ships of moderate displacement. First-line cruisers are from 7,500 to 10,000 tons displacement, mount guns up to 8 inches in caliber, have up to 5 inches in side armor, and are capable of speeds in excess of 32 knots. They are intended for scouting, screening fleet movements, raiding, and similar purposes. Cruisers may be further classified as—

1. Heavy (CA), armed with 8-inch or near 8-inch guns.

2. Light (CL), armed with guns usually 6 inches or less.

3. Antiaircraft, whose total armament may be used against aircraft.

(*c*) *Destroyers* (DD) are high-speed, unarmored naval vessels of approximately 1,500 tons displacement armed principally with torpedoes. In addition to making torpedo attacks, they may employ depth charges against submarines and may be used as mine layers. They mount guns of less than 6-inch caliber for their own defense and to attack unarmored enemy vessels.

(*d*) *Submarines* (SS) operate either under water or awash (on the surface). They are armed with the torpedo. In addition the larger ones are armed with mines and guns. Aside from raiding operations, reconnaissance, and attempts against vessels within a fortified harbor, submarines have little use against coast defenses.

(*e*) *Torpedo boats* (PT) are similar to, but generally inferior to, destroyers.

(*f*) *Minor war vessels* consist of gunboats, mine layers (CM), escort vessels, and patrol vessels.

(*g*) *Auxiliary vessels* consist of such ships as transports (AP), hospital ships, tenders, mine sweepers (AM), and tugs. Transports and mine sweepers are usually commercial vessels with no armor and with but a few guns of 6-inch or smaller caliber. All vessels of this type are exceedingly vulnerable to the fire of all types of seacoast armament.

(*h*) *Small craft* consist of small auxiliary vessels and the modern motor torpedo boat, a small vessel of great speed armed with torpedoes, mines, and automatic weapons.

(*i*) *Landing boats* may vary from small, fast, surf boats with a capacity of one squad, to large, self-propelled lighters capable of landing light tanks. All may be armed with automatic weapons.

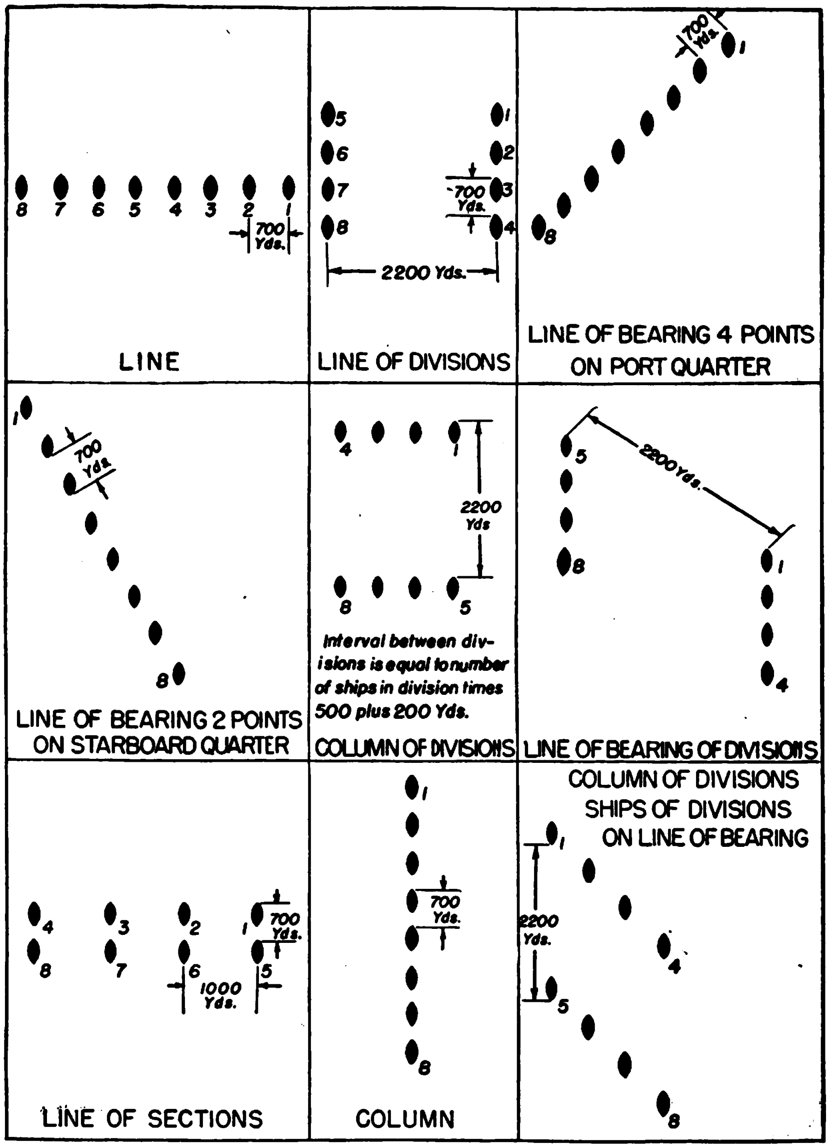
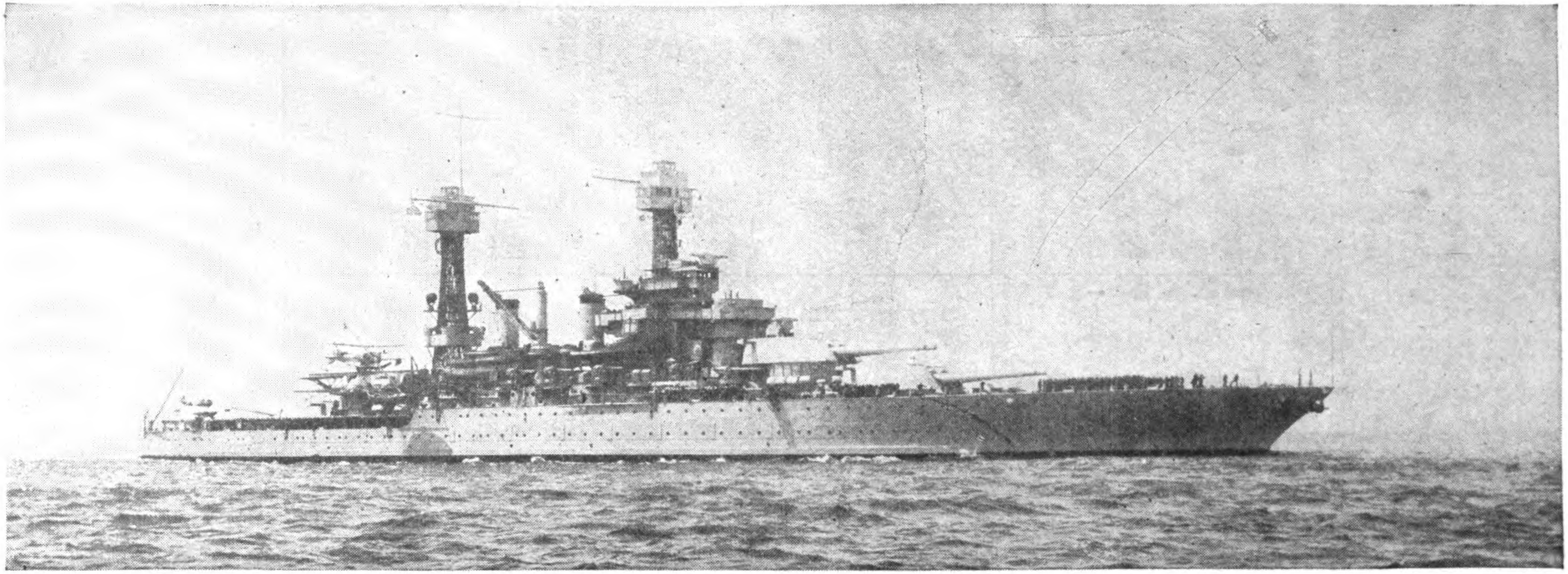


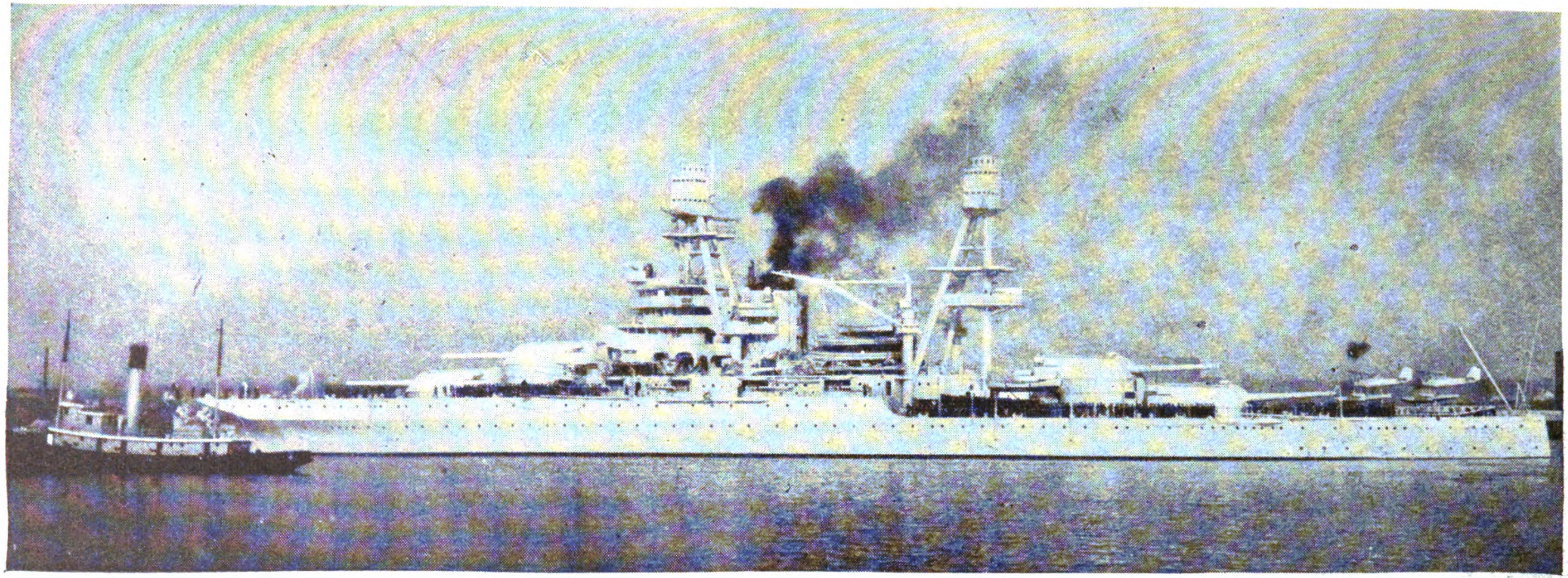
FIGURE 202.—Fleet formations.



Displacement—32,000 tons; length—624 feet; beam—98 feet; draught—31¼ feet.
Guns—Eight 16-inch, twelve 5-inch, eight 5-inch (AA).
Armor—Belt, 16 to 14 inches; deck, 3-inch; turrets, 18 to 9 inches; conning tower, 16-inch.

Torpedo tubes—Two 21-inch submerged.
Speed—21 knots.
Sister ships—*Colorado* and *Maryland*. The *California* and *Tennessee* are similar.

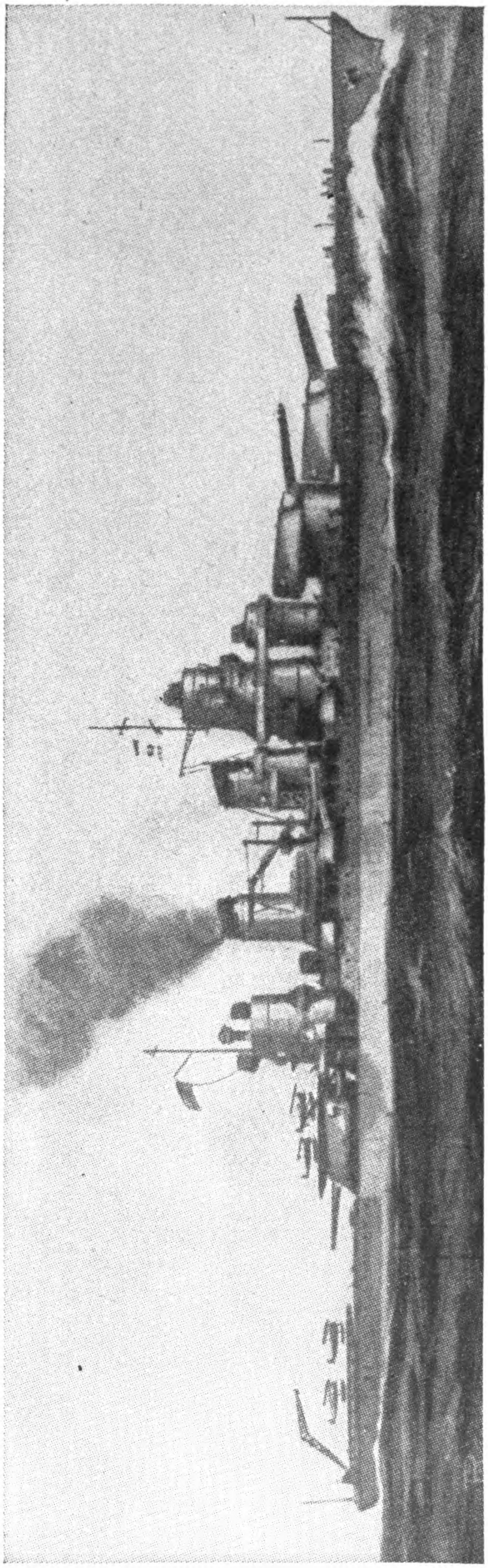
FIGURE 203.—United States battleship *West Virginia*.



Displacement—32,000 tons; length—624 feet; beam—97 feet; draught—29⅝ feet.
Guns—Twelve 14-inch, fourteen 5-inch, eight 5-inch (AA).
Armor—Belt, 13½ inch; deck, 3-inch; turrets, 18 to 9 inches; conning tower, 16-inch.
Torpedo tubes—Two 21-inch submerged. (Probably removed now.)
Speed—21 knots.
Sister ship—*Pennsylvania*.

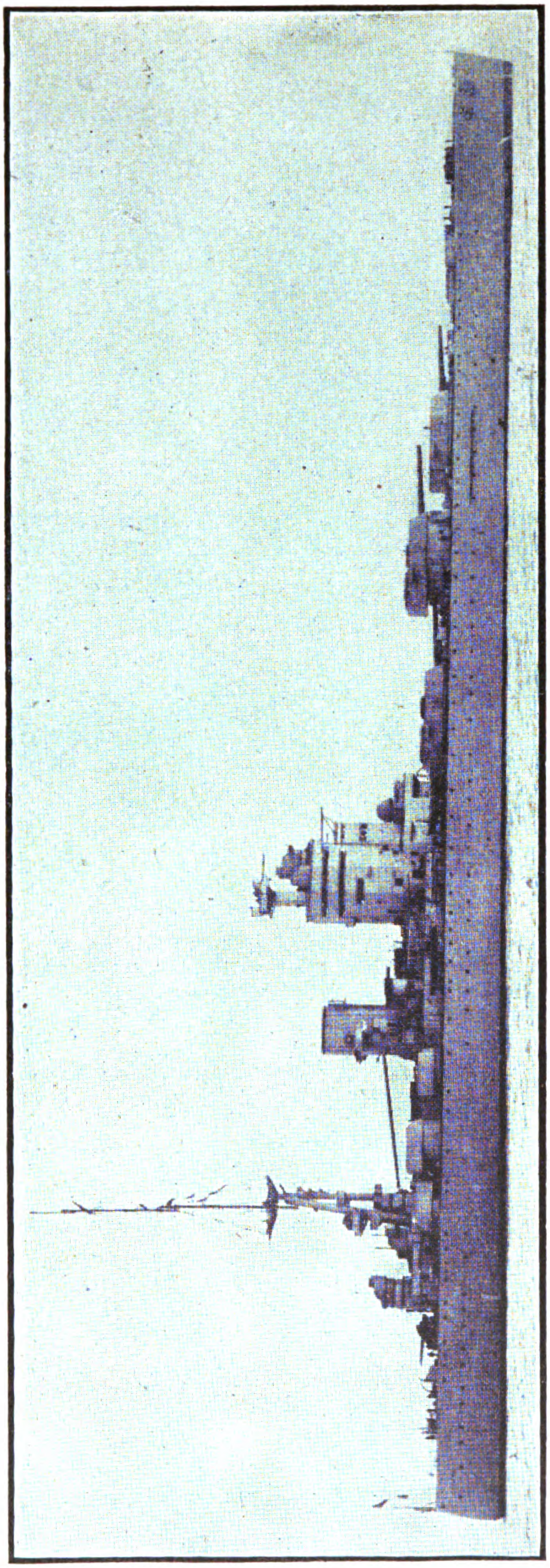
FIGURE 204.—United States battleship *Arizona*.

NOTE.—Ships of the class shown in the above figure, as well as those of the *Nevada* and *New Mexico* classes, either have been or are being remodeled. The alterations consist of the substitution of tripod for cage masts, 5-inch, 25-cal. AA guns for 3-inch AA, increased underwater protection, additional protective deck armor, and a certain amount of re-arrangement of the torpedo defense and antiaircraft batteries. Because of these modifications the data given above may not be exactly correct. New engines have been installed to compensate for any increased weight in order to maintain the designed speed.



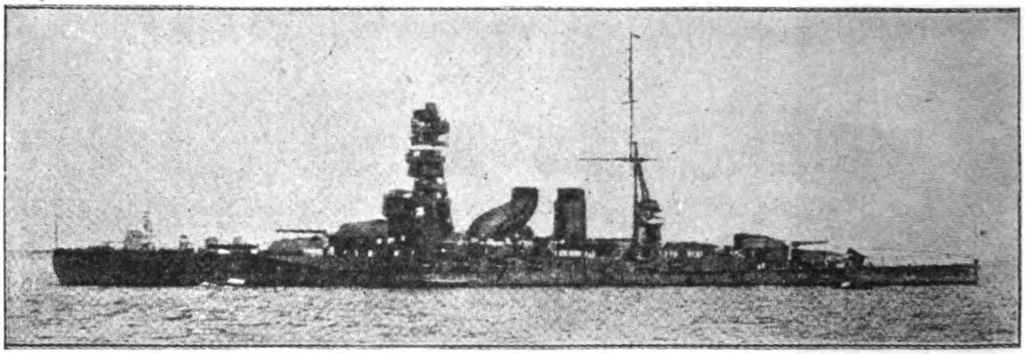
Displacement—35,000 tons.
Speed—30 knots.
Guns—Nine 16-inch; twenty 5-inch, dual purpose.
Aircraft—4.
Armor—Belt, 16-inch; upper deck, 6-inch; lower deck, 4-inch.
Length—750 feet.

FIGURE 205.—United States battleship *Washington*.



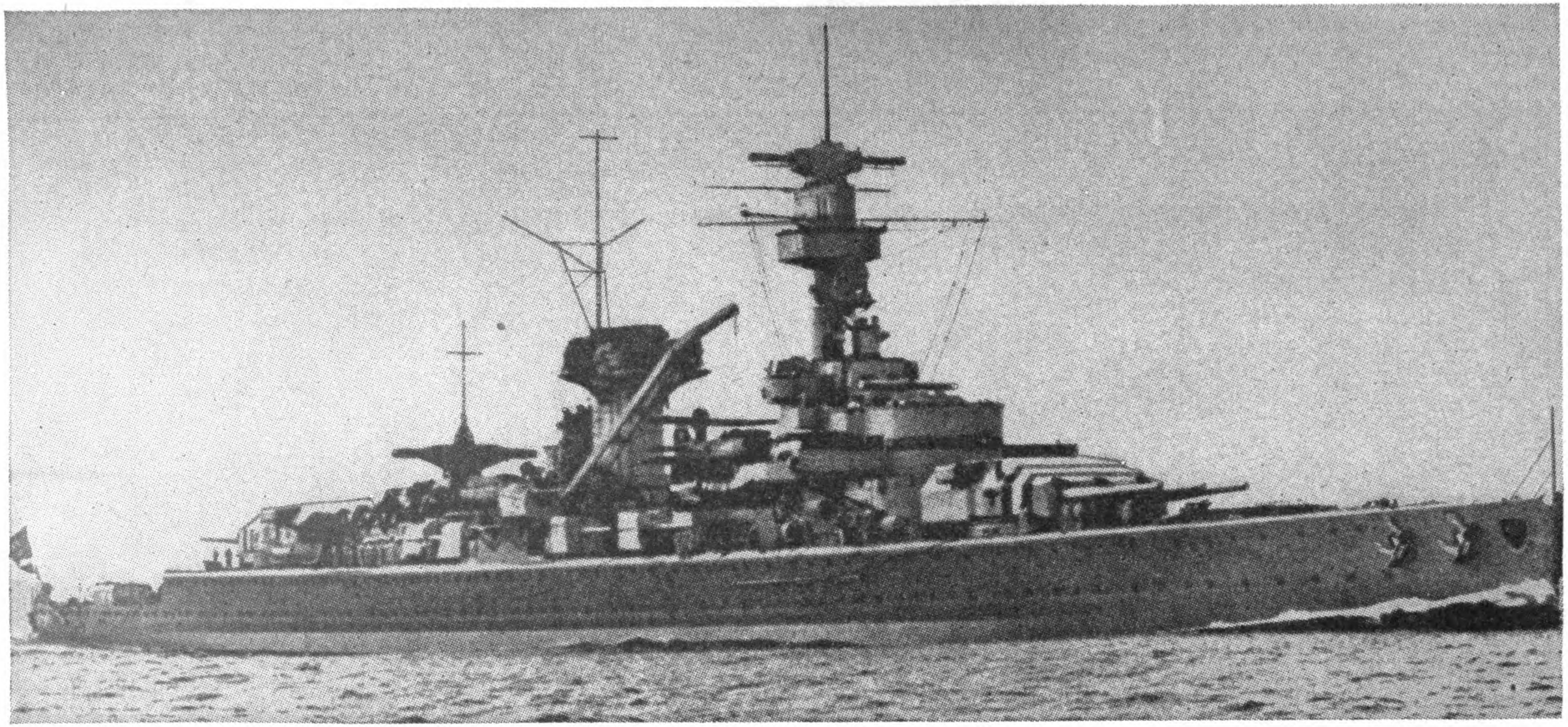
Displacement—35,000 tons.
Length—710 feet.
Beam—106 feet.
Draught—32 feet.
Torpedo tubes—Two submerged.
Speed—23 knots.
Guns—Nine 16-inch; twelve 6-inch; six 4.7-inch (AA).
Armor—Belt, 14-inch; turrets, 16 to 9 inches; deck, 6¼-inch.

FIGURE 206.—British battleship *Nelson* (sister ship *Rodney*).



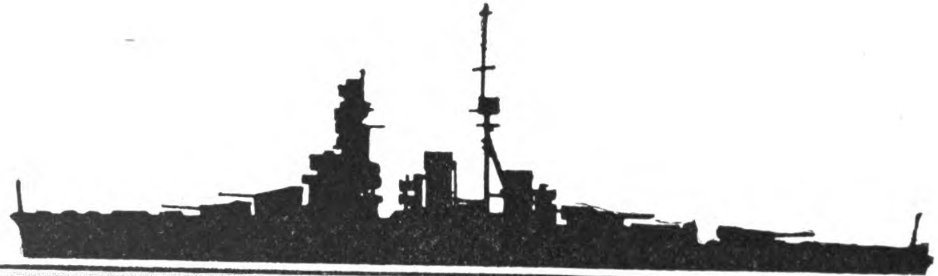
Displacement—32,720 tons.
Length—700 feet.
Beam—95 feet.
Draught—30 feet.
Guns—Eight 16-inch ; twenty 5.5-inch ; four 3.3-inch (AA).
Armor—Belt, 13- or 12-inch ; deck, 3½-inch (7-inch above magazines, boilers, and engine room) ; turrets, 14-inch ; conning tower, 12-inch.
Torpedo tubes—Four 21-inch submerged, four above the water.
Speed—23 knots.

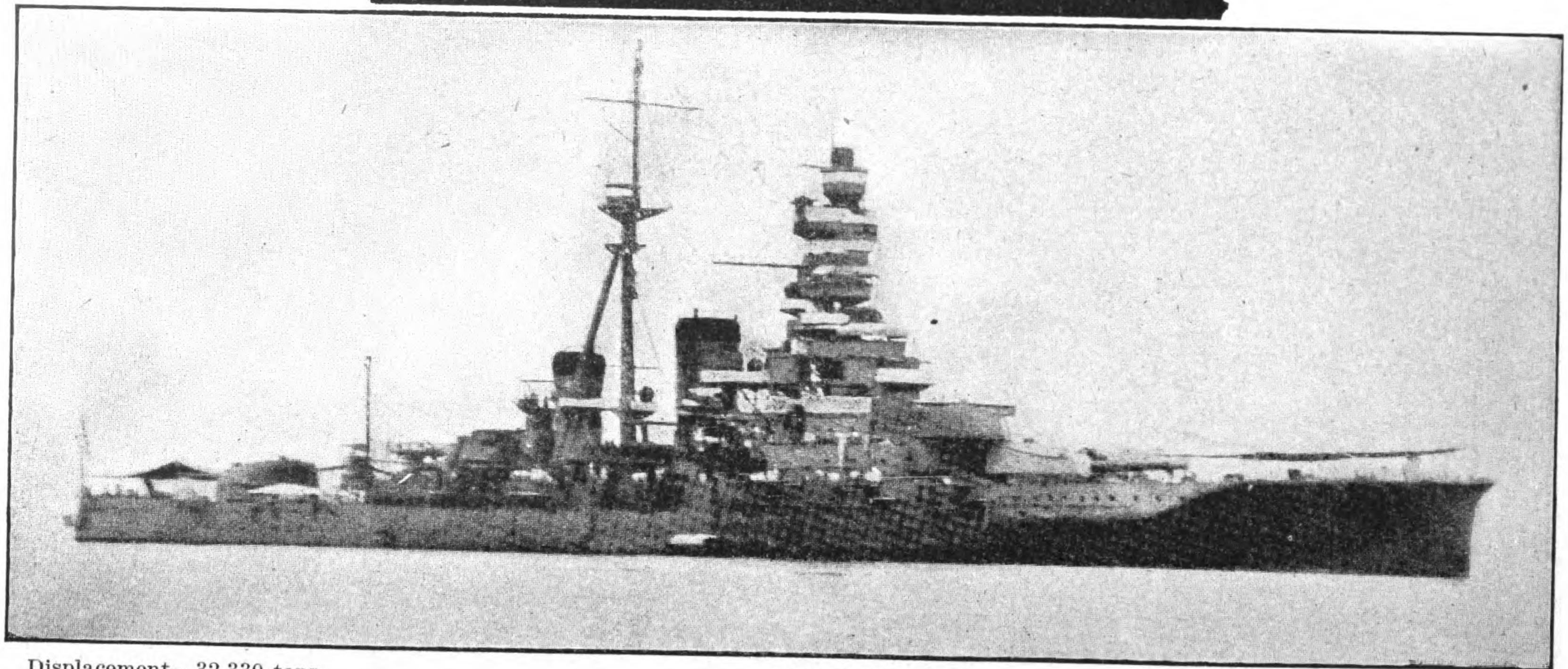
FIGURE 207.—Japanese battleship *Mutsu*.



Displacement—10,000 tons.
Length—593 feet.
Beam—67½ feet.
Draught—21⅔ feet.
Speed—26 knots.
Guns—Six 11-inch; eight 5.9-inch; six 4.1-inch (AA); eight 3-pdr. (AA); ten machine guns.
Torpedo tubes—Eight 21-inch.
Aircraft—Two.
Armor—Belt, 4-inch with 1½-inch internally; turrets, 4-inch bases, 7-inch faces, 2- to 3-inch sides; conning tower, 5-inch, 2-inch roof; deck 1½- to 2¼-inch, 3-inch over magazine.

FIGURE 208.—German pocket battleship *Lutzow* (ex *Deutschland*).

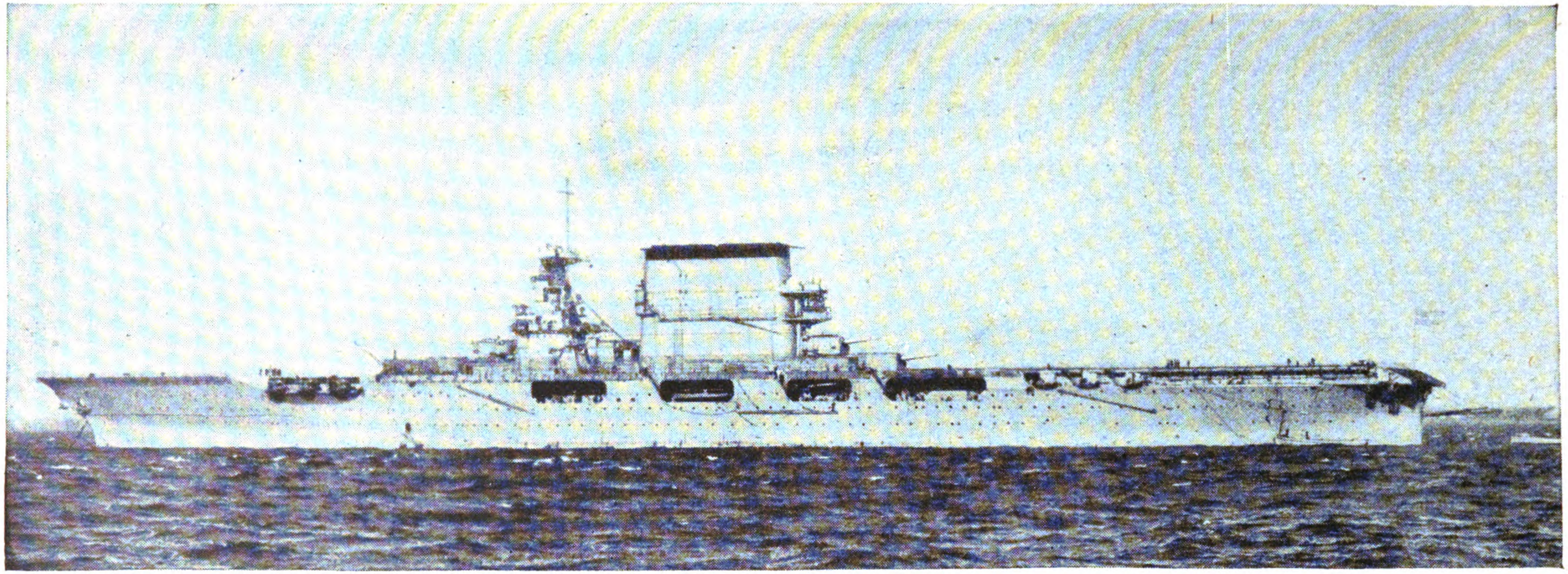




Displacement—32,330 tons.
Length—704 feet.
Beam—95 feet.
Draught—27½ feet.
Torpedo tubes—Four 21-inch submerged.

Speed—28 knots.
Guns—Eight 14-inch; sixteen 6-inch; four 3-inch (AA).
Armor—Belt, 8-inch; turrets, 10 to 9 inches; conning tower, 10 to 9 inches; deck 6¾-inch.

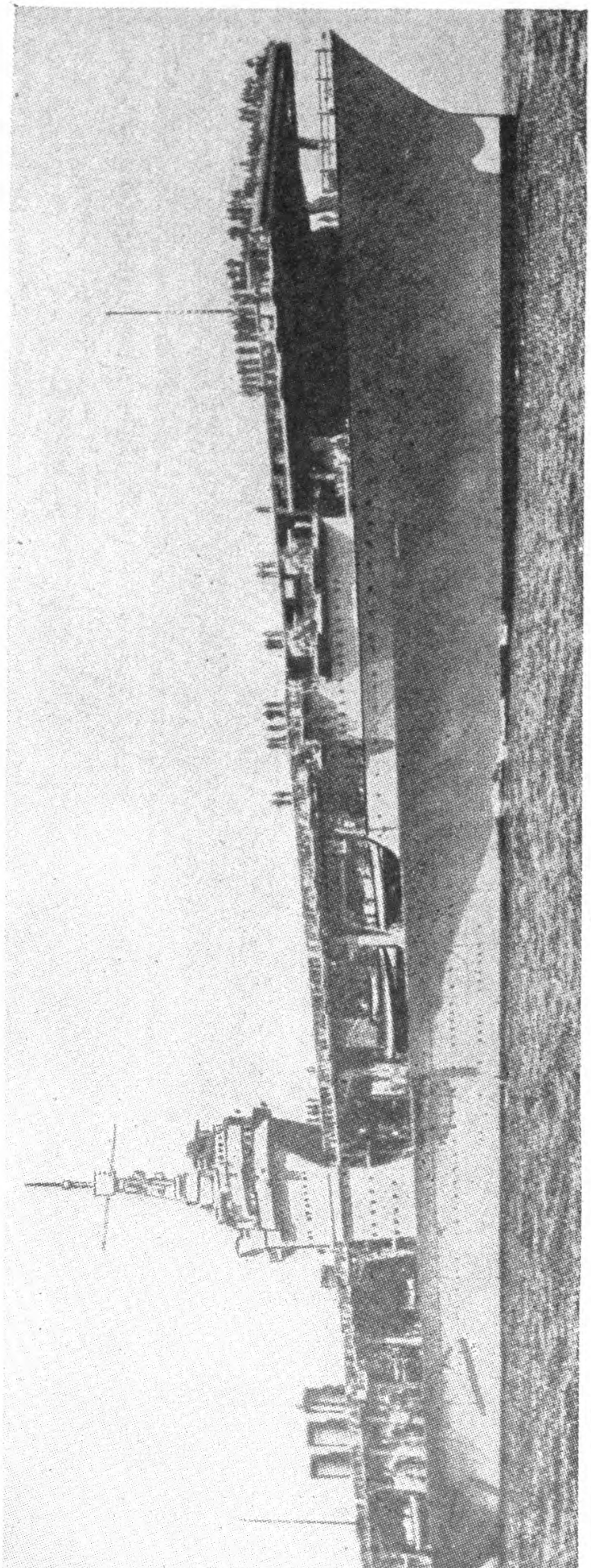
FIGURE 209.—Japanese battle cruiser *Haruna*.



Displacement—33,000 tons.
Length—888 feet.
Beam, over flight deck—90 feet.
Draught—25½ feet.
Guns—Eight 8-inch; twelve 5-inch (AA).

Armor—Belt, 6-inch; deck, 3-inch, triple hull and bulge protection.
Airplanes—120.
Speed—33 knots.
Sister ship—*Saratoga*.

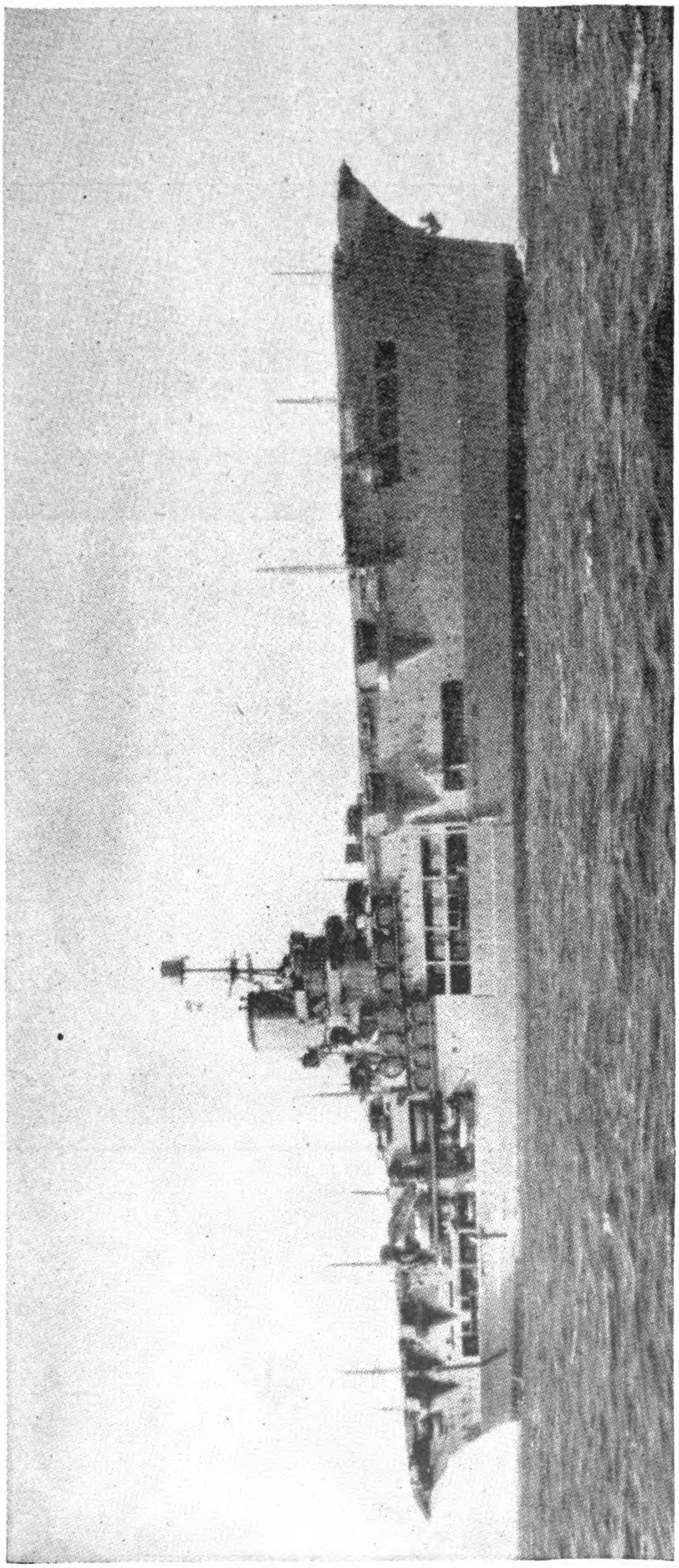
FIGURE 210.—United States aircraft carrier *Lexington*.



Displacement—14,500 tons.
Length—769 feet.
Beam—80 feet 1 inch.
Draught—19⅔ feet.

Speed—30 to 35 knots.
Guns—Eight 5-inch (AA).
Aircraft—75.

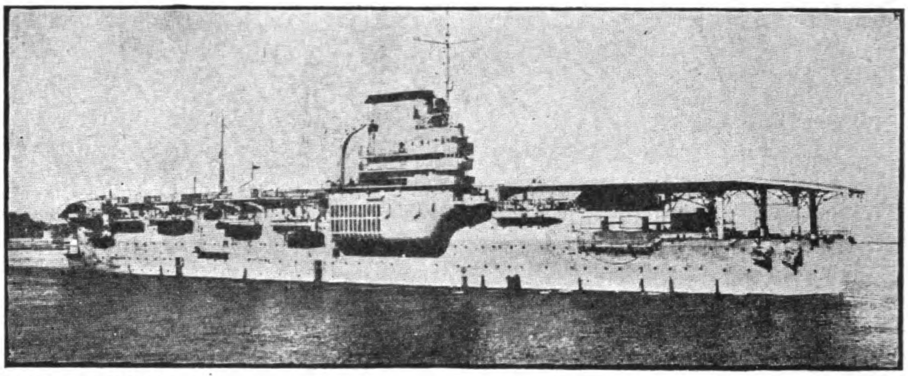
FIGURE 211.—United States aircraft carrier *Ranger*.



Displacement—22,000 tons.
Length—800 feet.
Beam, over flight deck—94 feet.
Draught—22⅝ feet.

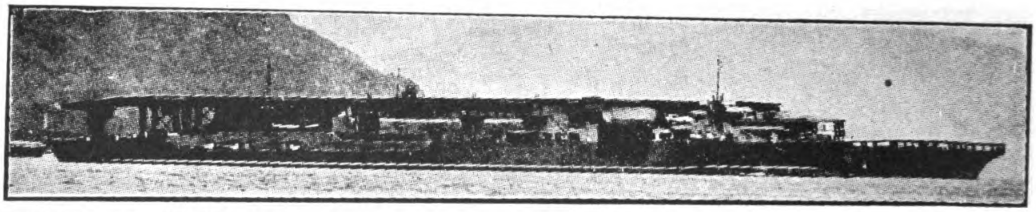
Guns—Sixteen 4.5-inch (dual purpose); four 3-pdrs; six multiple pompoms.
Airplanes—60.
Speed—31 knots.

FIGURE 212.—British aircraft carrier *Ark Royal.*



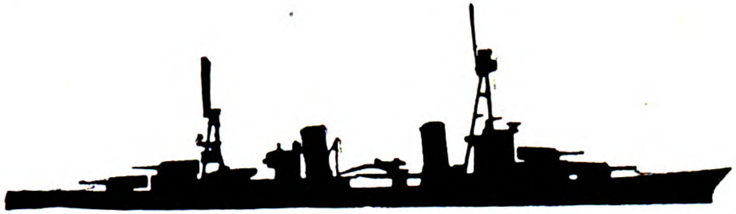
Displacement—22,150 tons.
Length—580 feet.
Beam, over flight deck—89 feet.
Draught—26 feet.
Guns—Ten 8-inch; four 4.7-inch; twelve 4.7-inch (AA).
Armor—Unknown.
Airplanes—40.
Speed—21 knots.

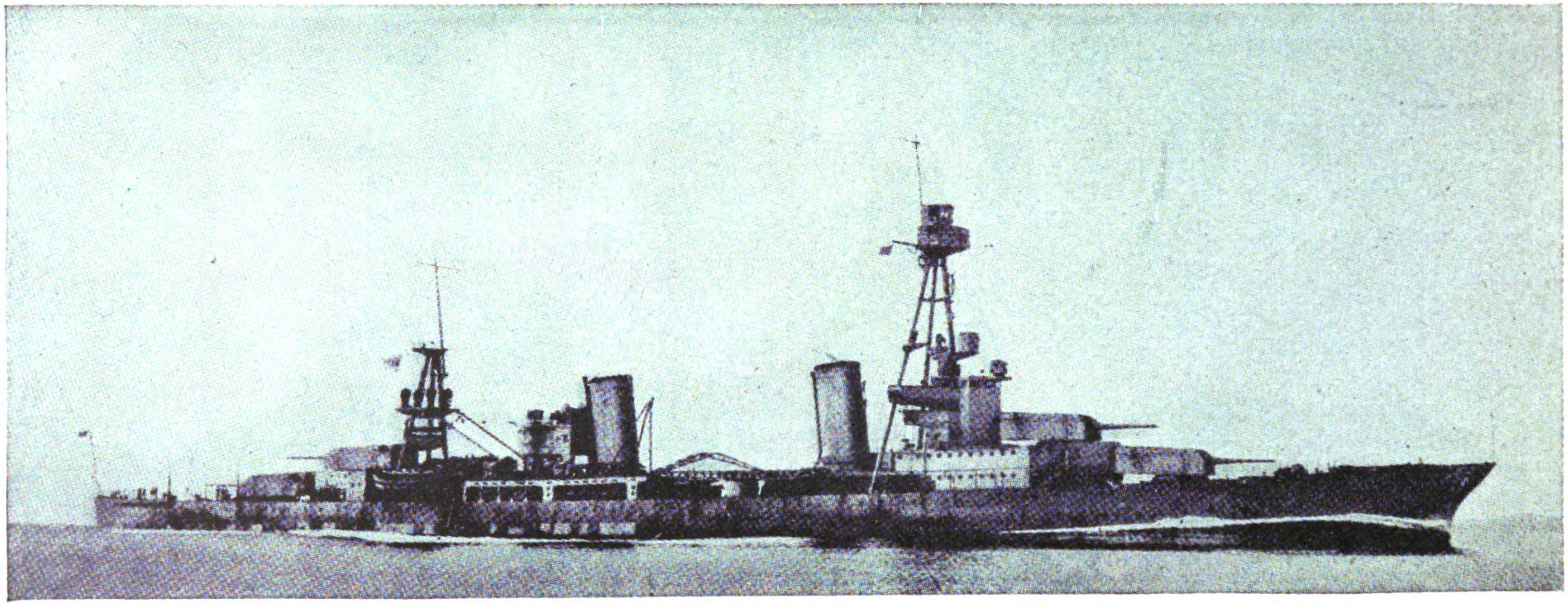
FIGURE 213.—French aircraft carrier *Bearn*.



Displacement—28,100 tons.
Length—780 feet.
Beam—92 feet.
Draught—21¼ feet.
Guns—Ten 8-inch; four 4.7-inch; twelve 4.7-inch (AA).
Armor—Unknown.
Airplanes—50.
Speed—28.5 knots.

FIGURE 214.—Japanese aircraft carrier *Akagi*.

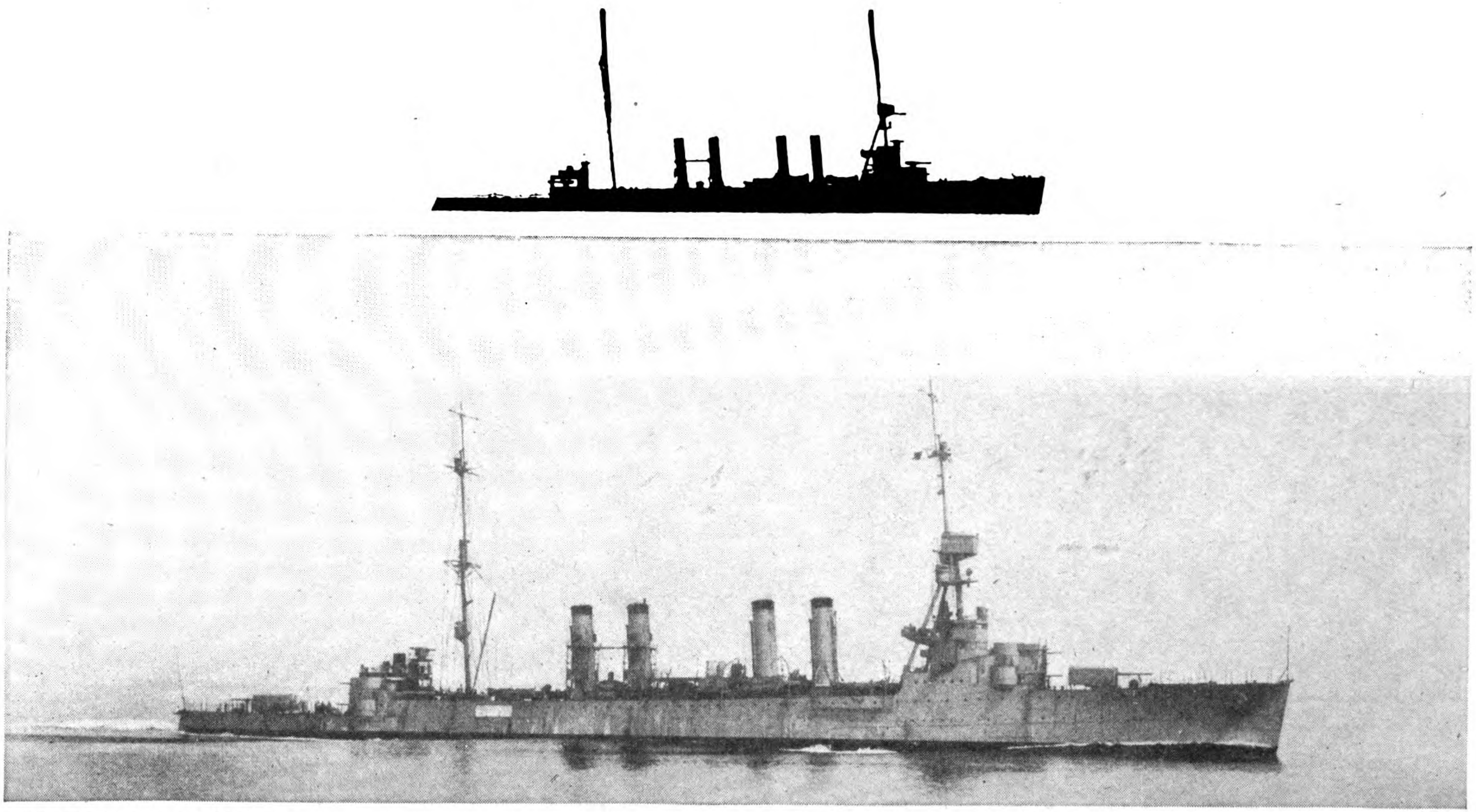




Displacement—10,000 tons.
Length—585 feet.
Beam—64 feet.
Draught—19 feet.

Torpedo tubes—Six 21-inch.
Speed—33 knots.
Guns—Ten 8-inch; four 5-inch (AA).
Armor—Side, 1½-inch; gunhouse, 1½-inch; deck, 3-inch.

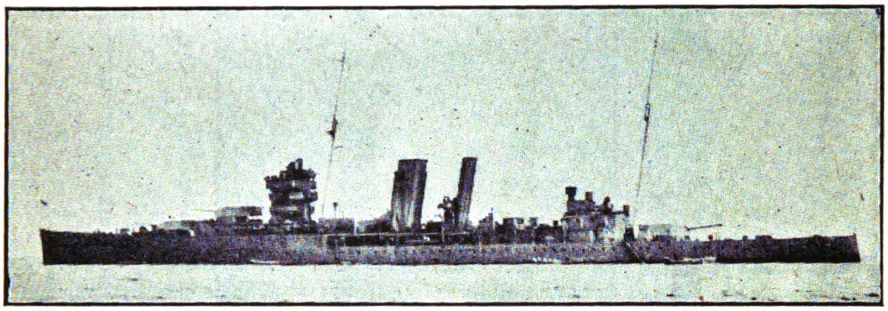
FIGURE 215.—United States cruiser *Salt Lake City*.



Displacement—7,500 tons.
Length—555 feet.
Beam—55 feet.
Draught—$15\frac{1}{2}$ feet.

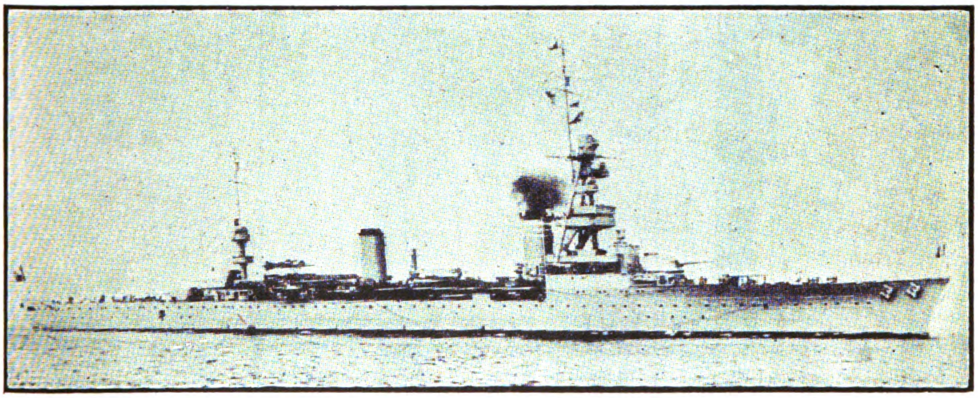
Torpedo tubes—Six 21-inch.
Speed—34 knots.
Guns—Twelve 6-inch; four 3-inch (AA).
Armor—Side, 3-inch; deck, $1\frac{1}{2}$-inch.

FIGURE 216.—United States cruiser *Marblehead*.



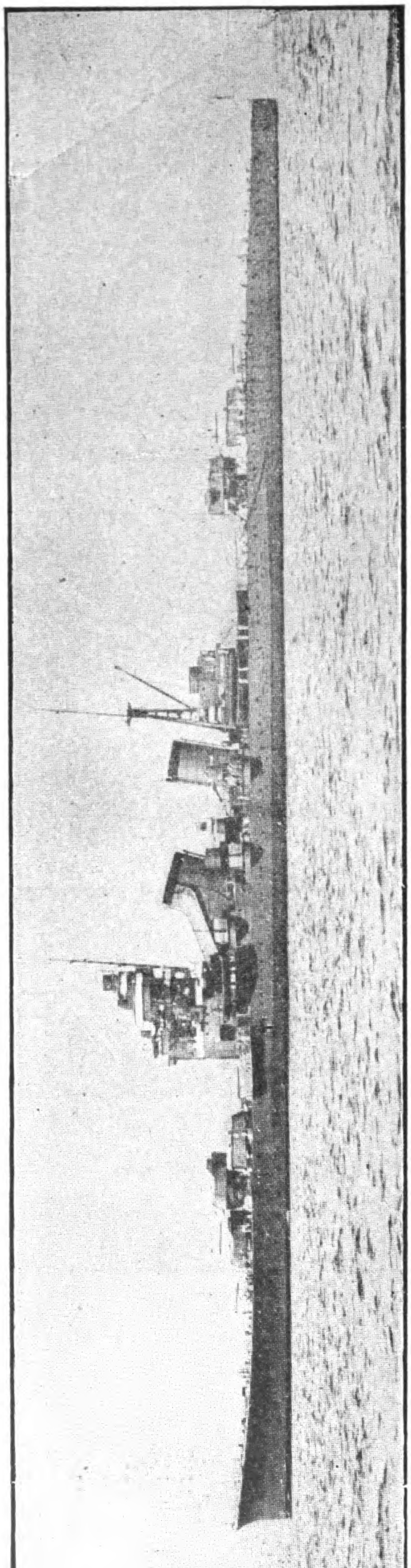
Displacement—8,400 tons.
Length—575 feet.
Beam—57 feet.
Draught—17 feet.
Guns—Six 8-inch; four 4-inch (AA).
Armor—Deck, 2-inch; conning tower, 3-inch.
Torpedo tubes—Six 21-inch.
Speed—32 knots.

FIGURE 217.—British cruiser *York*.



Displacement—9,940 tons.
Length—617 feet.
Beam—65 feet.
Draught—20 feet.
Guns—Eight 8-inch; eight 3.5-inch (AA).
Armor—Thin over engine and boiler spaces. Fitted with external bulges.
Torpedo tubes—Six 21-inch.
Speed—33 knots.

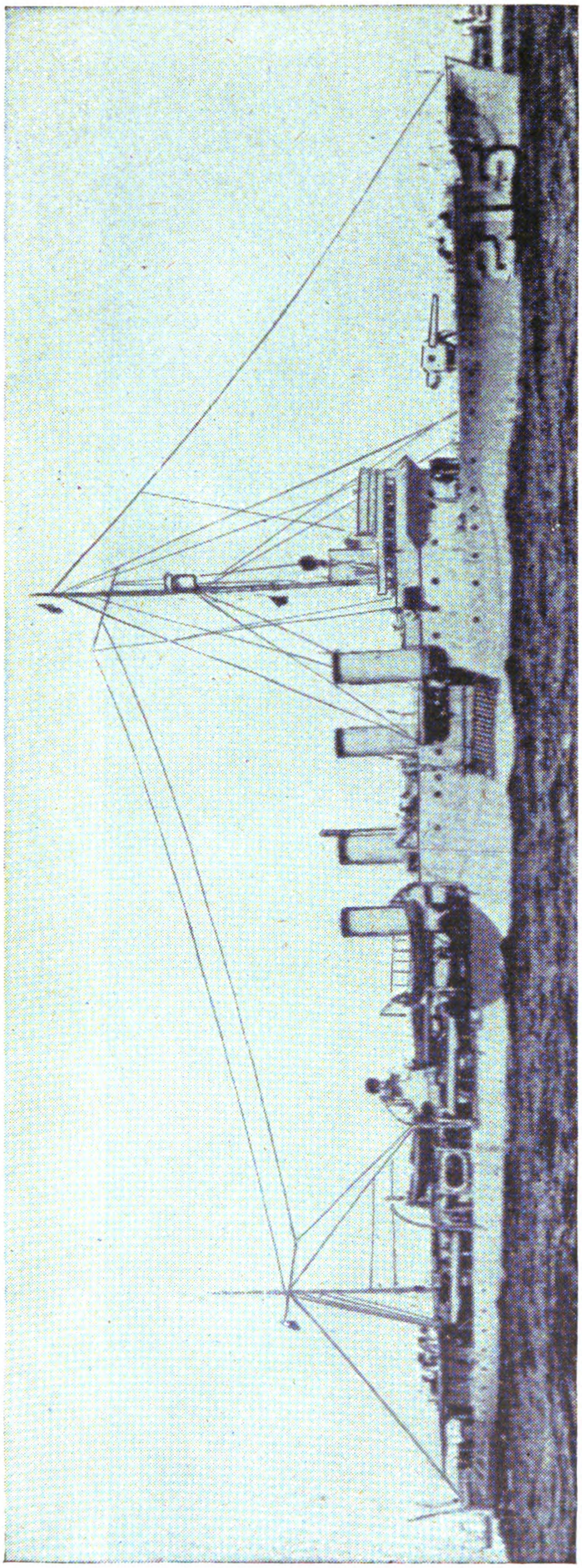
FIGURE 218.—French cruiser *Suffern*.



Displacement—10,000 tons.
Length—640 feet.
Beam—57 feet.
Draught—16½ feet.

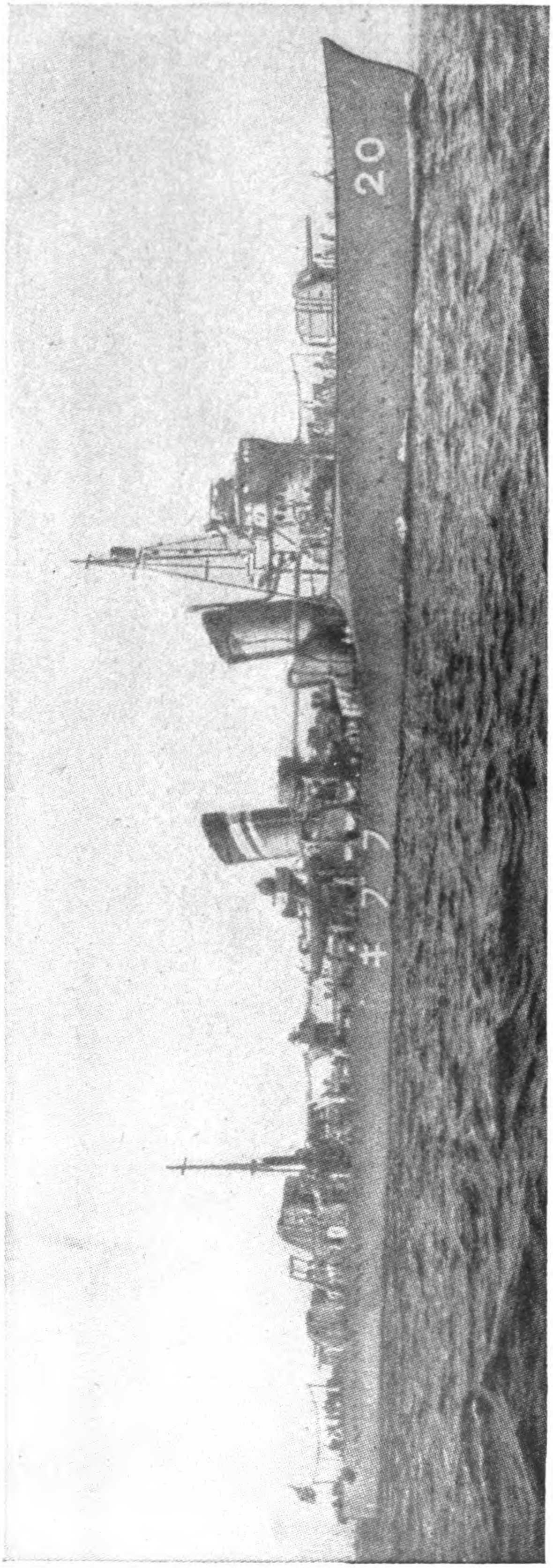
Torpedo tubes—Twelve 21-inch above water.
Speed—33 knots.
Guns—Ten 8-inch; six 4.7-inch (AA).
Armor—Belt, 3 to 4 inches; deck, unknown; turrets, unknown.

FIGURE 219.—Japanese cruiser *Nachi*.



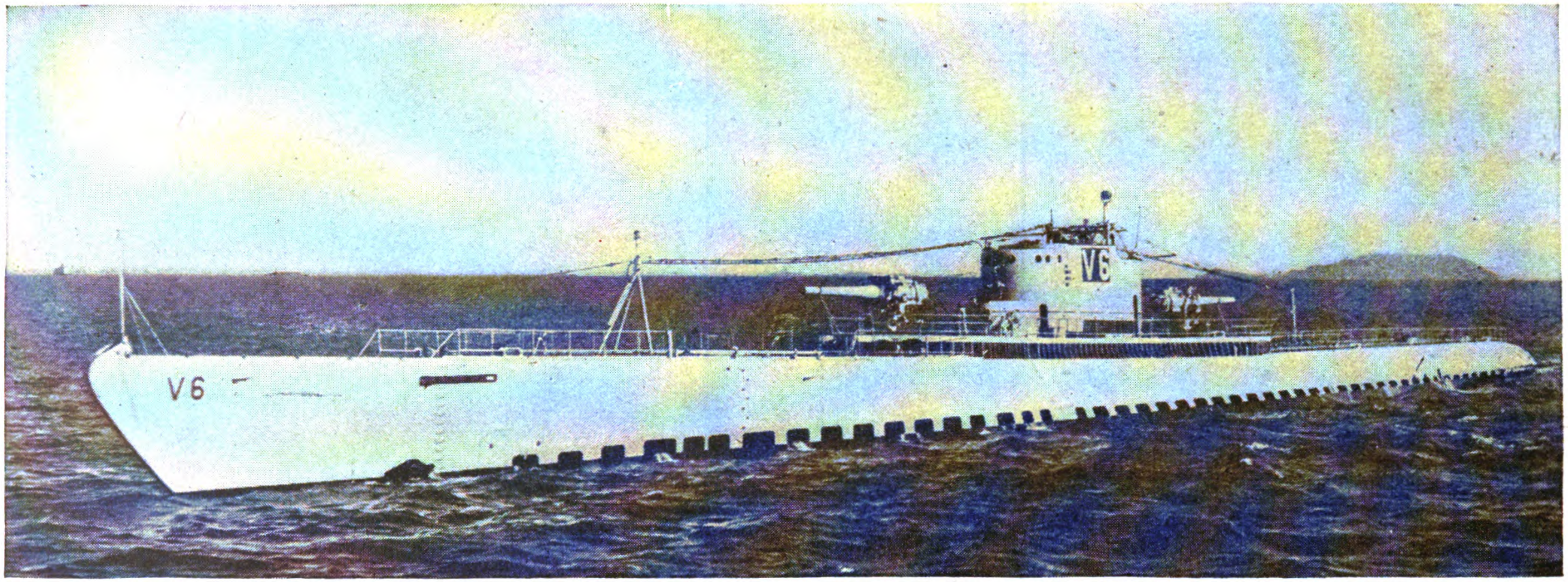
Displacement of this type, 1,020 to 1,190 tons; speed 35 knots.

FIGURE 220.—United States destroyer *Borie* (flush decker).



Displacement—1,700 tons; speed, 34 knots.

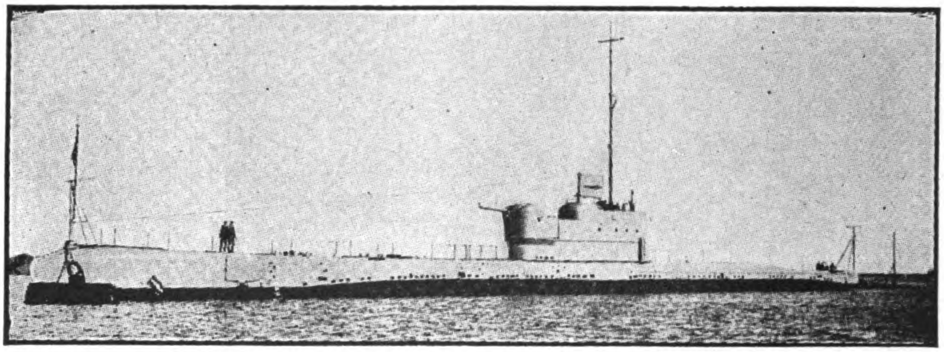
FIGURE 221.—Japanese destroyer *Hubuki.*



Displacement—2,760 tons.
Length—371 feet.
Guns—Two 6-inch.

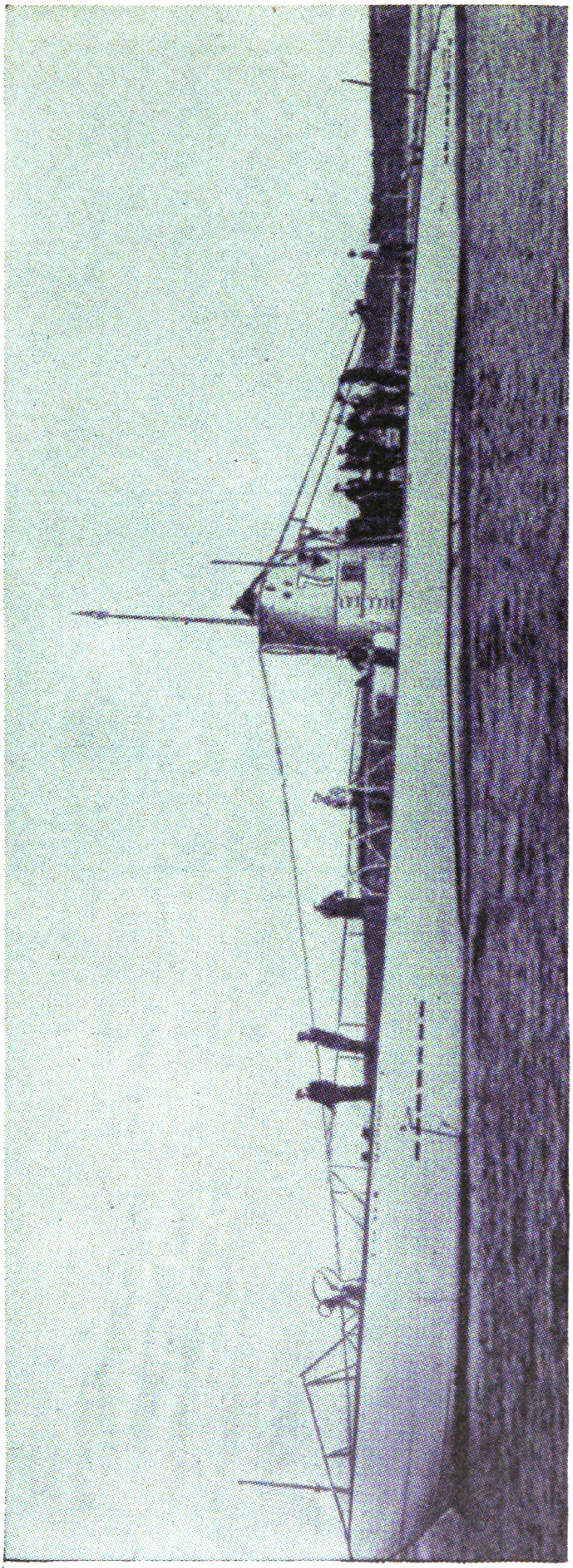
Torpedo tubes—Six 21-inch.
Speed 17/8.5 knots.

FIGURE 222.—United States submarine *Nautilus* N–2 (ex V–6).
NOTE.—The speed given indicates the surface and submerged speeds in the order given.



Displacement—1,475 tons.
Length—260 feet.
Torpedo tubes—Eight 21-inch.
Speed—17.5/9 knots.
Guns—One 4.9-inch.

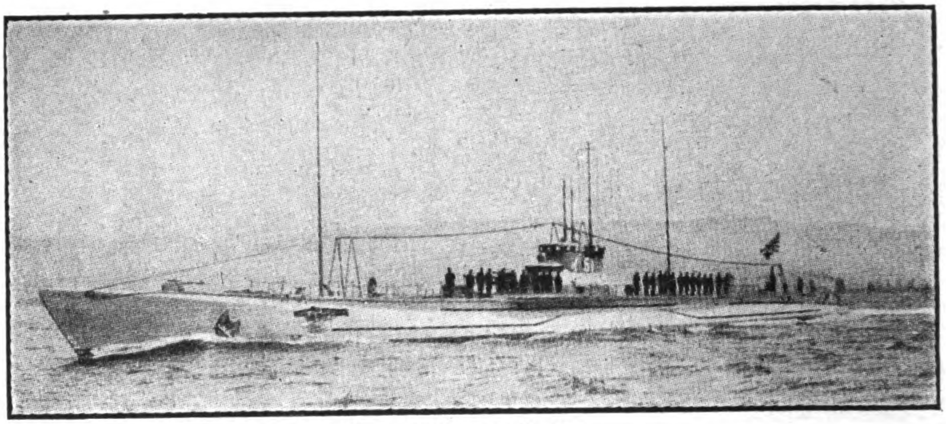
FIGURE 223.—British submarine *Perseus.*



Displacement—250–330 tons.
Length—136½ feet.
Torpedo tubes—Three 21-inch.

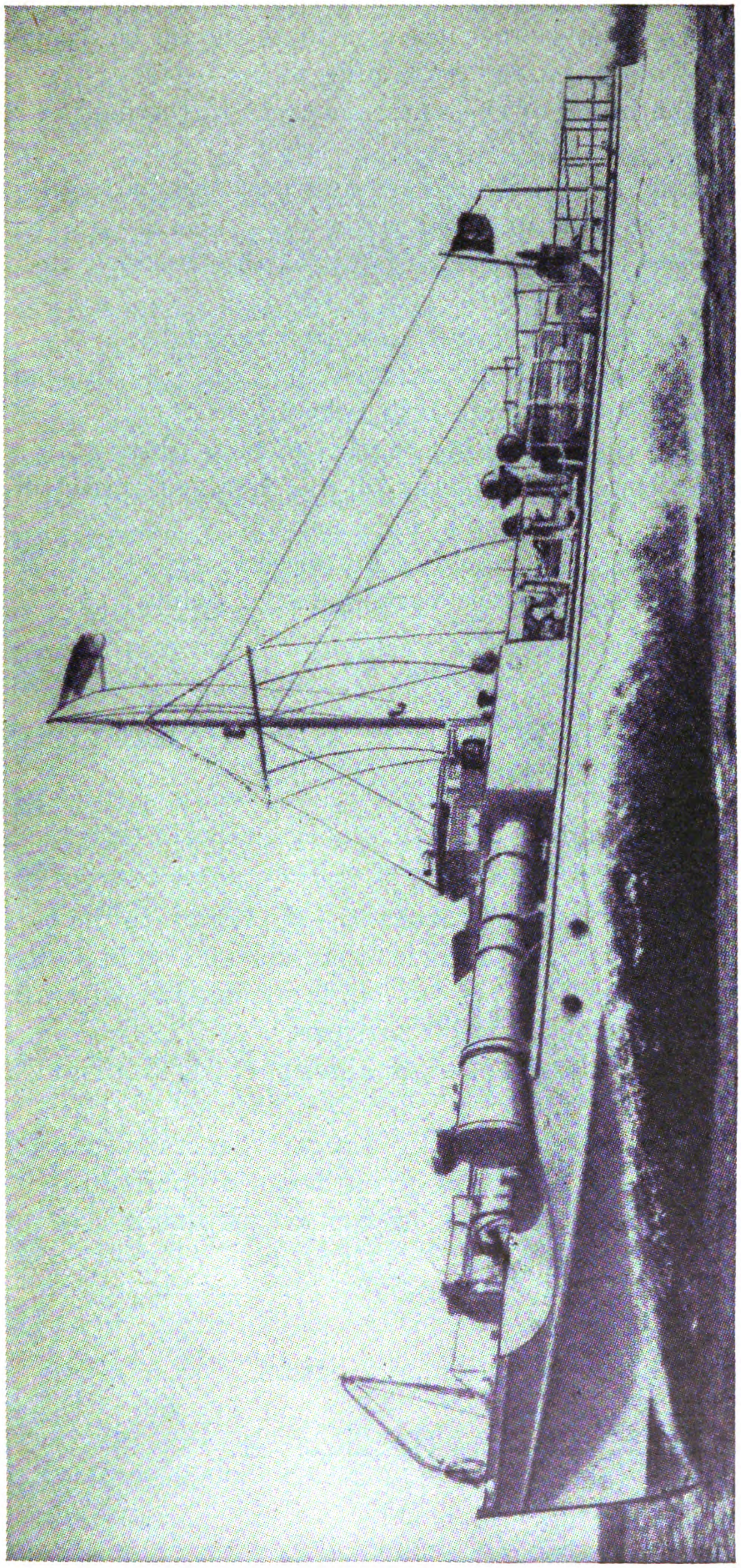
Speed—13/7 knots.
Guns—One 1-pounder (AA).

FIGURE 224.—German submarine, U–7 coastal type, Nos. 1–24.



Displacement—1,635 tons.
Length—320 feet.
Torpedo tubes—Six 21-inch.
Speed—19/10 knots.
Guns—One 4.7-inch.

FIGURE 225.—Japanese submarine *Mitsu Bishi* type.



Displacement—62 tons.
Length—93 feet.
Speed—30–36 knots.

Torpedo tubes—Two 19.7-inch.
Guns—One 1-pounder (AA).

FIGURE 226.—German motor torpedo boat, S6–25 (Schnellboote).

In addition to the identification and indication of naval targets as prescribed for first-class gunner, the candidate should be prepared to answer the following questions pertaining to his battery:

Q. What are the limits of the water subareas in the field of fire of this battery?

Q. Where are the main channels leading past this battery?

Q. Where are the areas of shoal water?

Q. What are the limits of field of fire of this battery, right and left?

Q. What are the maximum and minimum ranges?

Q. What local shipping, if any, makes daily trips past this battery?

Q. What are the approximate boat schedules?

Q. What are the distinguishing marks of these ships?

Q. What other commercial boats do you frequently see while at drill?

Q. What time of day is the field of fire most nearly clear?

Q. What are the ranges to the various datum points?

Section V

INDICATION, IDENTIFICATION, AND CHARACTERISTIC FEATURES OF AIRCRAFT

143. Classes and types of aircraft.—*Q.* What are the two general classes of aircraft? *A.* Heavier-than-air and lighter-than-air.

Q. Name the general types of lighter-than-air aircraft. *A.* Observation balloons and dirigible airships.

Q. What are the general types of airships? *A.* Nonrigid, semirigid, and rigid.

Q. What are the heavier-than-air aircraft generally called? *A.* Airplanes or aeroplanes, seaplanes, flying boats, amphibians.

Q. What are the general types of combat airplanes used by the United States Army? *A.*

(1) Pursuit.
(2) Bombardment.
(3) Reconnaissance, observation, and liaison.
(4) Transport.

Q. How are pursuit airplanes classified? *A.*

(1) Interceptor.
(2) Single-place fighter.
(3) Multiplace fighter.

Q. How are bombardment airplanes classified? *A.*
(1) Heavy.
(2) Medium.
(3) Light.

Q. What is the normal mission of pursuit airplanes? *A.* The interception, attack, and destruction of enemy aircraft in the air. The *interceptor* is usually a single seater with one or two powerful engines. The *single-place fighter* is used for escort and patrol in addition to normal pursuit missions. The *multiplace fighter* is used for escort and patrol duty near important objectives and against ground-troop formations.

Q. What are the normal missions of *heavy* and *medium* bombardment airplanes? *A.* To carry heavy bomb loads to great distances for attack of material objectives, and also to conduct long range strategic reconnaissance over land and sea.

Q. What are the normal missions of *light* bombardment airplanes? *A.* Light bombardment airplanes (formerly designated as attack) are designed to attack objectives of light construction, routes of communication, airdromes, troop movements, and concentrations of troops in the open or under light shelter. The light bombardment airplane is the striking element of combat aviation which operates in direct support of ground forces. Identification of this type of airplane is especially important to ground troops.

Q. What are the normal missions of reconnaissance, observation, and liaison airplanes? *A.* They gather information of the enemy. The latter two types operate in conjunction with our own forces performing fire-adjustment missions for artillery, maintaining contact with our front lines and marching columns, and carrying on other command, liaison, and courier missions.

Q. What are the missions of transport airplanes? *A.* Transport airplanes are not strictly a combat type of airplane. They are used for the transportation of personnel and supplies. Their importance is rapidly increasing when we consider the transportation of air-landing troops, parachute troops, and important supplies.

Q. What types of airplanes are employed by our Navy, and to what types of Army airplanes do they correspond? *A.*
(1) Scouting-observation airplanes corresponding to observation airplanes.
(2) Fighter airplanes corresponding to pursuit airplanes.
(3) Torpedo-bombardment airplanes corresponding to bombardment airplanes.

(4) Patrol airplanes which do not correspond to any special type of Army airplane. The Navy has no type of airplane corresponding to the Army light bombardment airplane.

Q. Does the Navy make more extensive use of the biplane type of airplane than the Army? *A.* Yes. They are used on carriers and on board other types of warships being launched from catapults. They are used for this purpose because they are more stable in flight at low air speeds than monoplanes.

Q. What are seaplanes and flying boats? *A.* They are airplanes equipped with floats (pontons) or boat-shaped hulls instead of wheels, so that they may alight on water. Seaplanes have floats while flying boats have hulls.

Q. What is an amphibian airplane? *A.* It is an airplane having a boat-shaped hull, and also equipped with wheels (that can be retracted when operating on water) so that it can alight or take off from either a land or water surface.

144. Identification and indication of aircraft.—*Q.* Why is it important that ground personnel be familiar with the appearance in flight, method of operation, and characteristic sounds of airplanes? *A.* These factors are the means by which airplanes are identified and indicated.

Q. What are the basic flight positions used for ready recognition of airplane types? *A.*

(1) Coming flight or front view.

(2) Passing flight or side view.

(3) Flight at lower altitude or top view.

(4) Overhead flight or bottom view.

(5) Maneuvering flight or perspective view.

Q. What is meant by coming flight or front view? *A.* All positions of flight in which only a general head-on view of the airplane may be had.

Q. What is meant by passing flight or side view? *A.* All positions of flight in which the side of the fuselage, vertical fin, and rudder are the major surfaces presented to view.

Q. What is meant by flight at lower altitude or top view? *A.* All positions of flight in which the upper sides of wings, fuselage, and horizontal tail surfaces are the major surfaces presented to view.

Q. What is meant by overhead flight or bottom view? *A.* All flight positions in which the under sides of wings, fuselage, and horizontal tail surfaces are presented to view.

Q. What is meant by maneuvering flight or perspective view? *A.* All flight positions which are different from straight and level

flight. It includes banking, turning, climbing, diving, and combinations of such maneuvers. The airplane may present, momentarily at least, nearly all of the views presented under other conditions of flight.

Q. What characteristics of outline of the airplane are most readily seen in overhead flight? *A*.

(1) *Shape of wing*.—The general shape and proportion of wings, as long and narrow, short and stubby.

(2) *Type and shape of nose*.—Nose extends much or little in advance of leading edge of wings; that is, plane is long-nosed or short-nosed.

(3) *Length and shape of fuselage*.—Compare the relatively short fuselage of the small and medium sized airplanes with the long, slender, streamlined appearance of the larger types.

(4) *Location and number of engines*.—In single-engined airplanes the engine is located in the nose and by its type determines the shape of the nose; that is, with radial engines the nose is blunt and stubby, while with in-line and V-type engines the nose is more slender and pointed. In multiengined airplanes the engines are usually housed in nacelles extending from the leading edge of the wings. In the unusual pusher types, the engines extend from the trailing edge of the wings. Even at great altitudes when the number of engine nacelles cannot be exactly determined, their presence will give an unmistakable irregular outline to the wings warranting identification as multiengined.

Q. What characteristics of outline are most readily seen in passing flight? *A*.

(1) *Shape and outline of the fuselage*.—It is short and chunky in smaller pursuit types; elongated and streamlined in larger types; long and thick bodied in larger bombardment types. Note outline being broken by such parts as cockpits, canopies over cockpits, and gun turrets.

(2) *Shape of nose*.—It may be slender and pointed, blunt and stubby, smoothly rounded, or shark-nosed.

(3) Note the *relative size of the vertical fin and rudder* compared to the fuselage.

Q. What characteristics of outline are most readily seen in coming or going flight? *A*.

(1) *Relationship of wings to fuselage*.—Has high-wing, mid-wing, low-wing, or parasol-wing types; dihedral angle, pronounced, moderate, or practically zero.

(2) *Number of engines.*—The irregularity of outline of wings will indicate a multiengined type.

(3) *Features of the vertical tail members.*—It is usually possible to identify single- and double-rudder types.

(4) *Undercarriages.*—Nonretractable landing gear is usually plainly visible.

Q. What characteristics of outline are most readily seen in maneuvering flight? *A*. All the features previously pointed out may be momentarily visible.

Q. What characteristic methods of operation of pursuit assist in its identification? *A*. Pursuit normally operates in formation with the squadron of eighteen airplanes as the largest group operating as a unit. An observer noting one such formation should look below and to the front of it and above and to the rear of it for other units.

Q. What characteristic methods of operation of heavy and medium bombardment assist in its identification? *A*. They operate in column of three plane elements (route column) with successive elements stepped up or down from front to rear. They usually fly straight courses at medium or high altitude unless attacked from the air or by antiaircraft fire.

Q. What characteristic methods of operation assist in the identification of light bombardment? *A*. They operate in formation at minimum or medium altitudes. They use the three plane element echeloned to the rear at approximately the same altitude. The normal operating unit is the squadron of nine airplanes with the largest formation the group of three squadrons. This type of aviation supports the operations of ground troops.

Q. What characteristics of operation of reconnaissance airplanes assist in their identification? *A*. They operate at any altitude from low to high; usually operate singly; fly straight courses unless attacked. Bombardment airplanes may perform long range reconnaissance.

Q. What characteristic methods of operation assist in identification of observation and liaison airplanes? *A*. They operate almost entirely within own lines; fly singly on various courses at low and medium altitudes; will be seen circling over own troops and troop columns to drop messages and observe panels.

Q. What are some of the characteristic sounds of pursuit airplanes in flight? *A*. Pursuit airplanes in flight are characterized by sounds of fast rhythm, high pitch, moderate volume, and by extreme variations in pitch and tone while maneuvering.

Q. What are some of the characteristic sounds of heavy and medium bombardment airplanes while in flight? *A*. They have a fairly deep pitch, a moderately heavy volume, and a steady tone and rhythm.

Q. What are some of the characteristic sounds of light bombardment airplanes while in flight? *A*. They have a heavy volume of sound due to low altitude; a fairly deep pitch, with tone and rhythm steady but varying considerably when maneuvering.

Q. State, in proper order, the information given and the terms used in indicating aircraft during daylight. *A*.

(1) *Designation of the reporting station* by name or number.

(2) *Number of airplanes*, when they can be counted. If they cannot be counted the word SEVERAL or the word MANY may be used.

(3) *Type of airplane*, such as OBSERVATION, PURSUIT, etc., when they can be identified. In other cases the word AIRPLANE is used.

(4) *Altitude*, in general terms as follows: VERY LOW (below 500 yards); LOW (500 to 2,000 yards); MEDIUM (2,000 to 5,000 yards); or HIGH (over 5,000 yards).

(5) *Location*, by the sector in which or toward which the aircraft are flying.

(6) *Direction of flight*, by one of the eight points of the compass: NORTH, NE, EAST, SE, SOUTH, SW, WEST, NW.

Q. State which of these elements of information are given in indicating aircraft at night. *A*. Designation of reporting station, number of airplanes (ONE, SEVERAL, or MANY), altitude, and location.

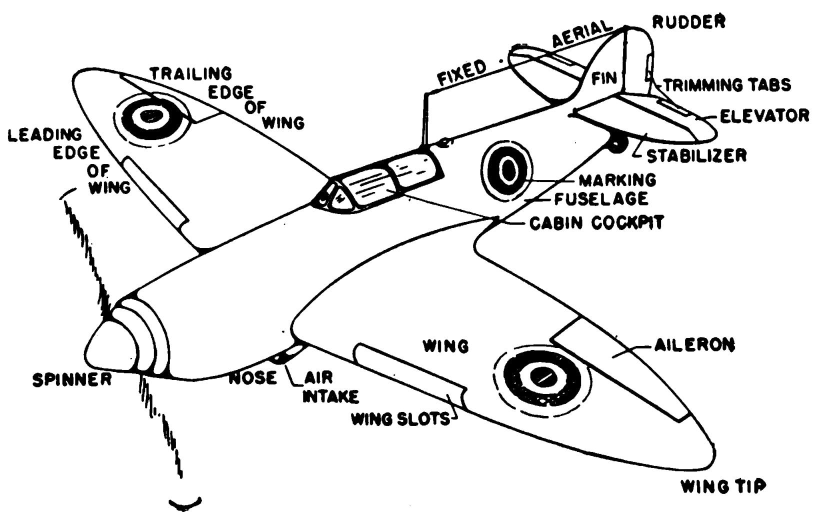


FIGURE 227.—Nomenclature of airplane parts.

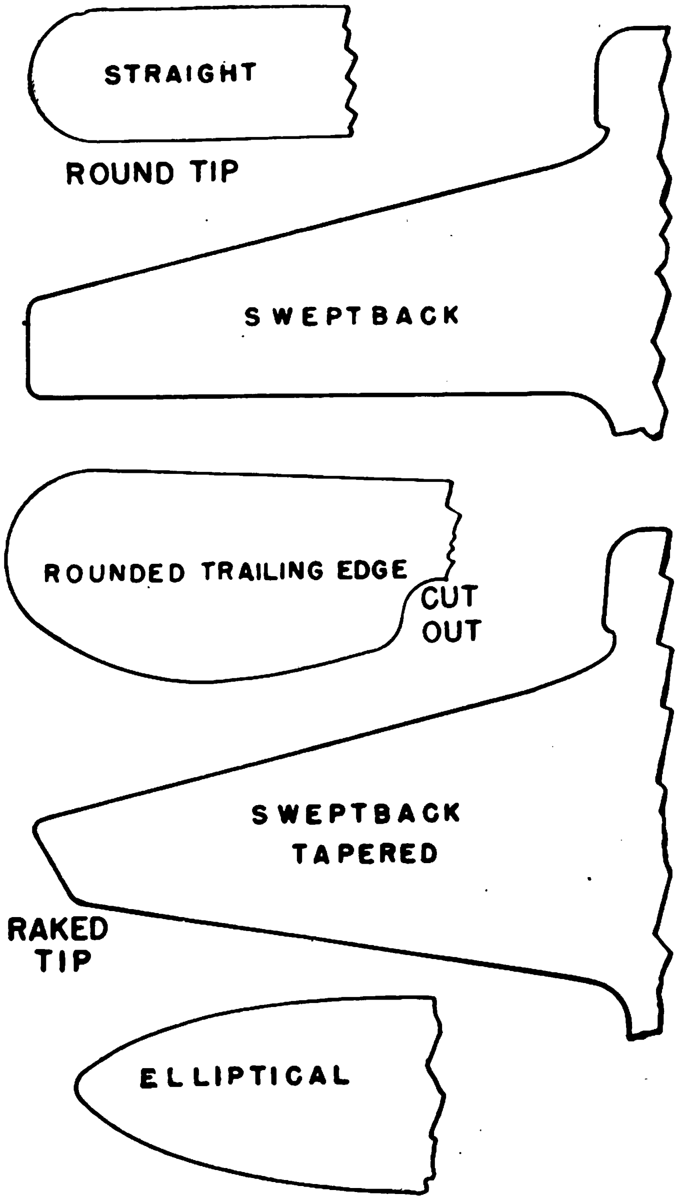


FIGURE 228.—Wing shapes.

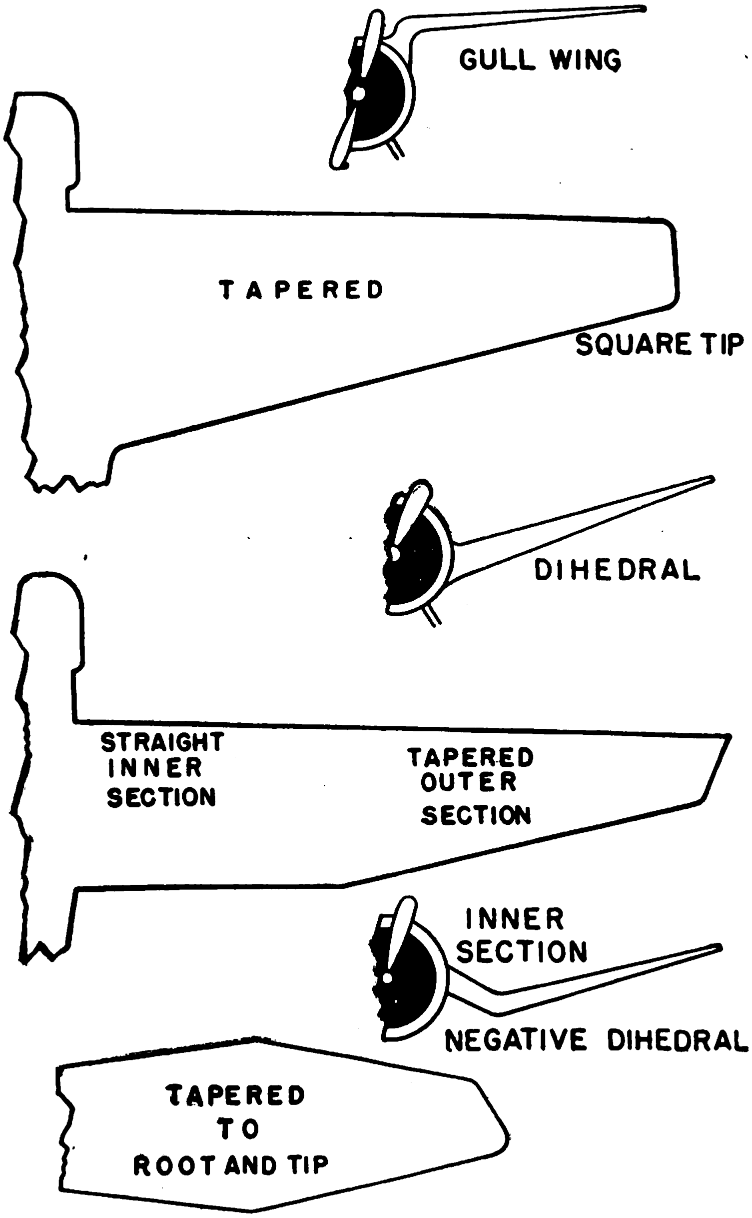


FIGURE 228.—Wing shapes—Continued.

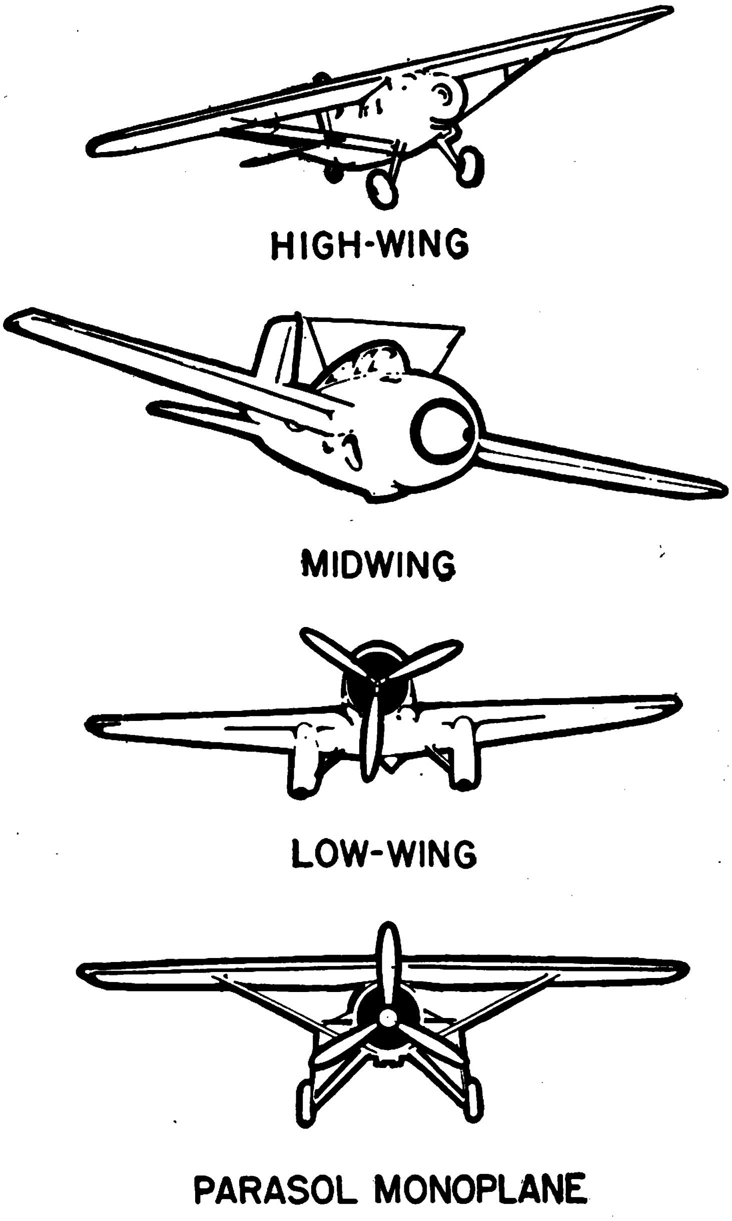


FIGURE 229.—Monoplanes.

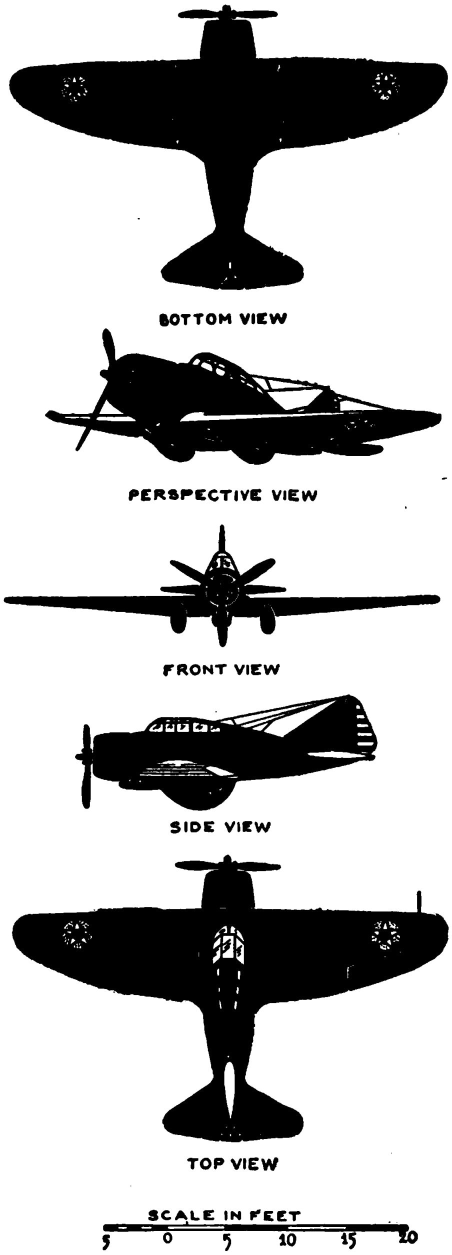


FIGURE 230.—Pursuit airplane.

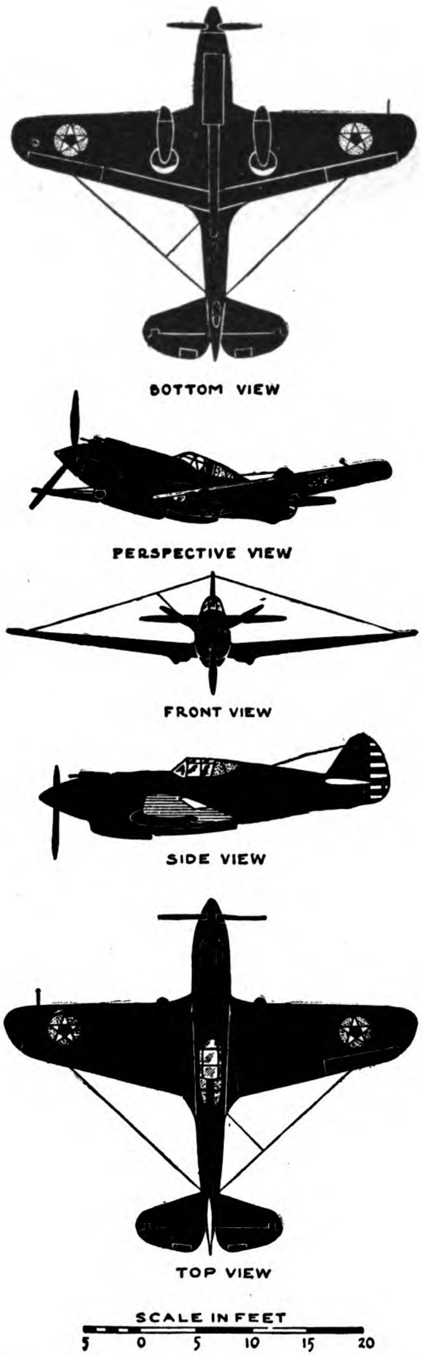


FIGURE 230.—Pursuit airplane—Continued.

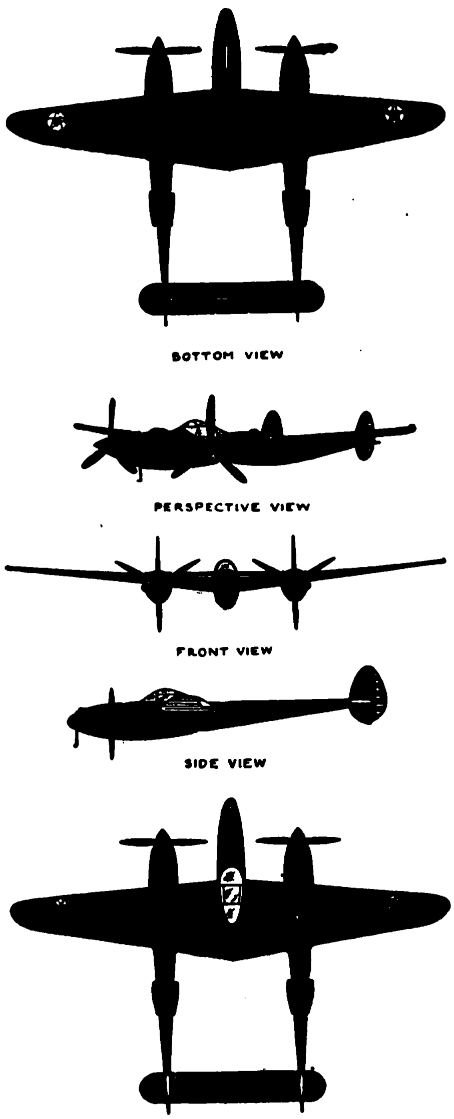
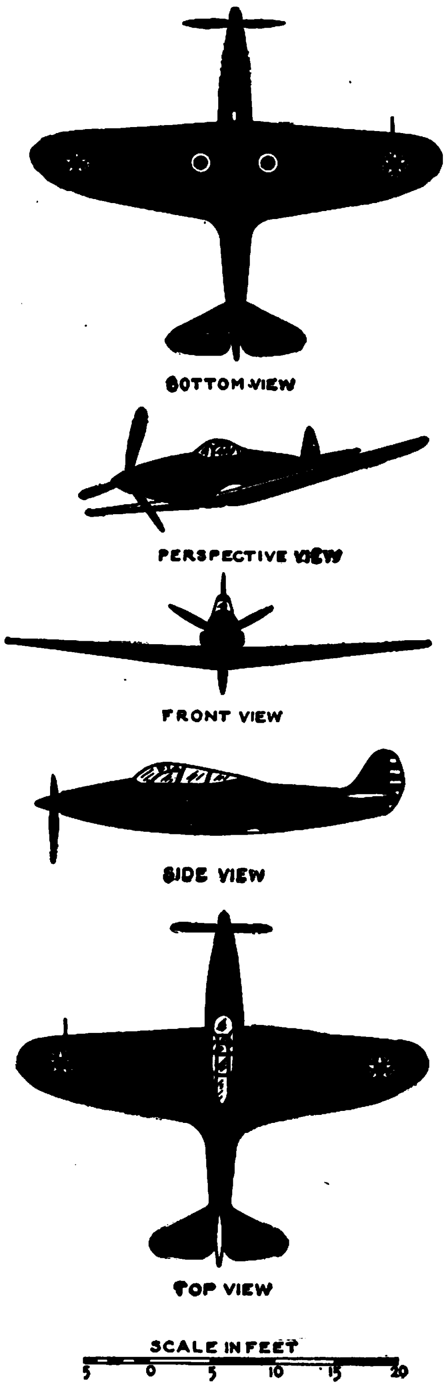


FIGURE 231.—Pursuit airplane (interceptor).



③

FIGURE 231.—Pursuit airplane (interceptor)—Continued.

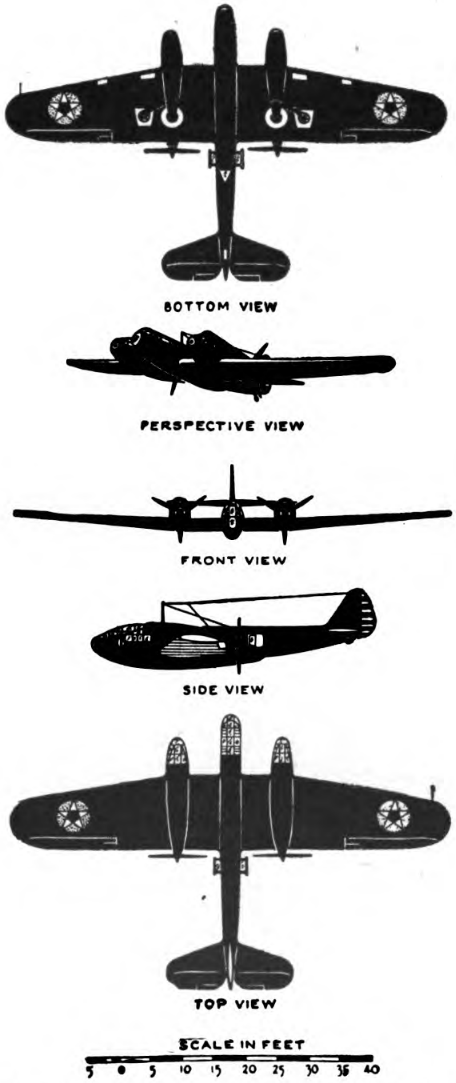


FIGURE 232.—Multiplace fighter airplane.

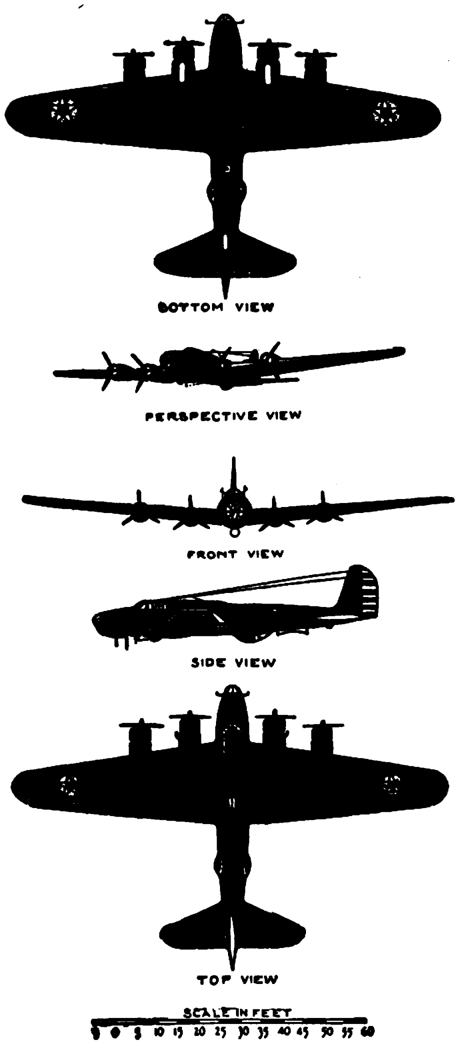


FIGURE 233.—Bombardment airplane.

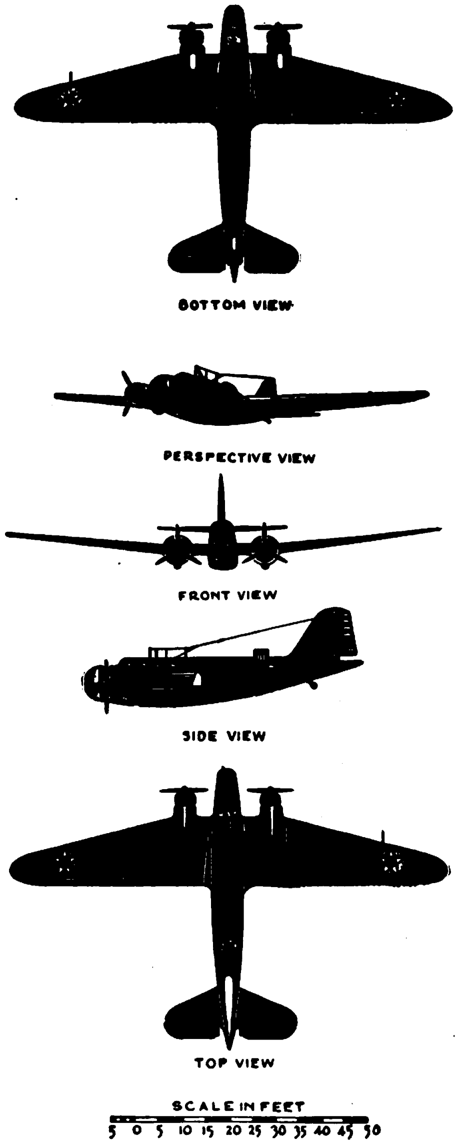


FIGURE 233.—Bombardment airplane—Continued.

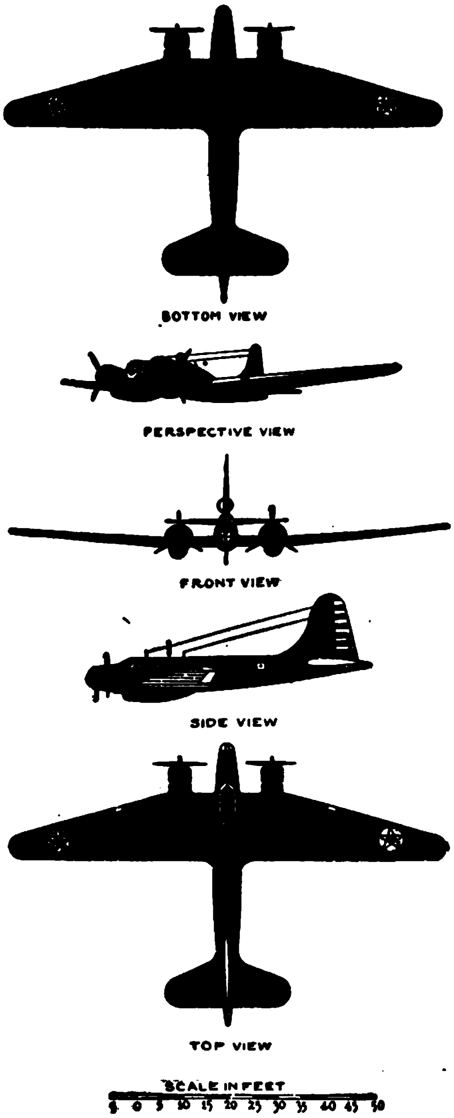


FIGURE 233.—Bombardment airplane—Continued.

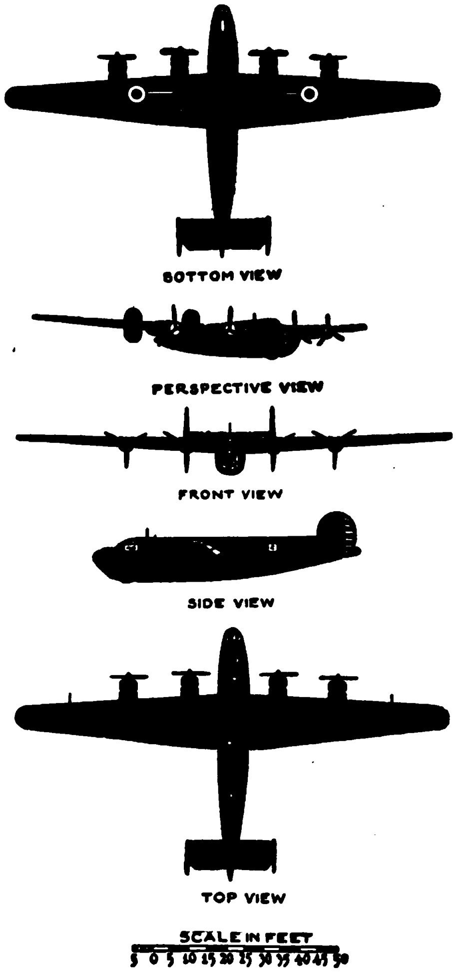


FIGURE 233.—Bombardment airplane—Continued.

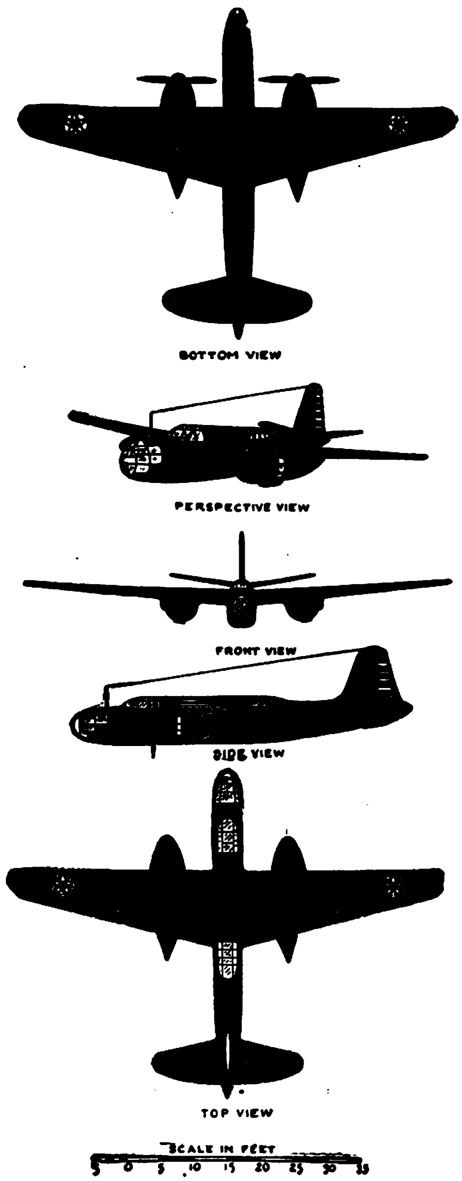


FIGURE 234.—Light borbardment (attack) airplane.

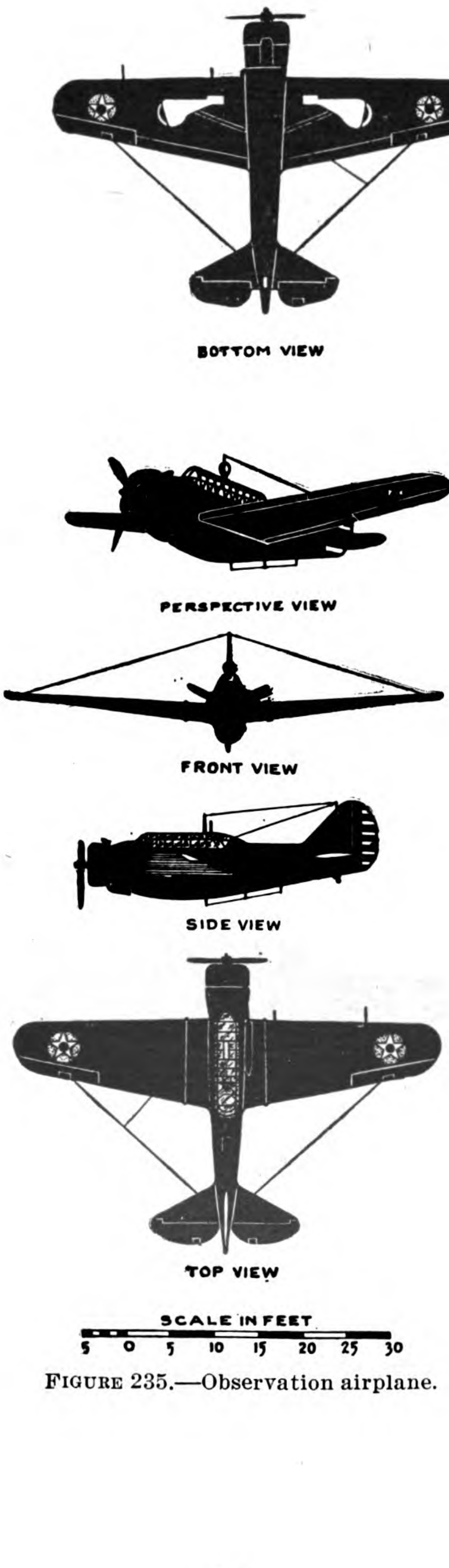


FIGURE 235.—Observation airplane.

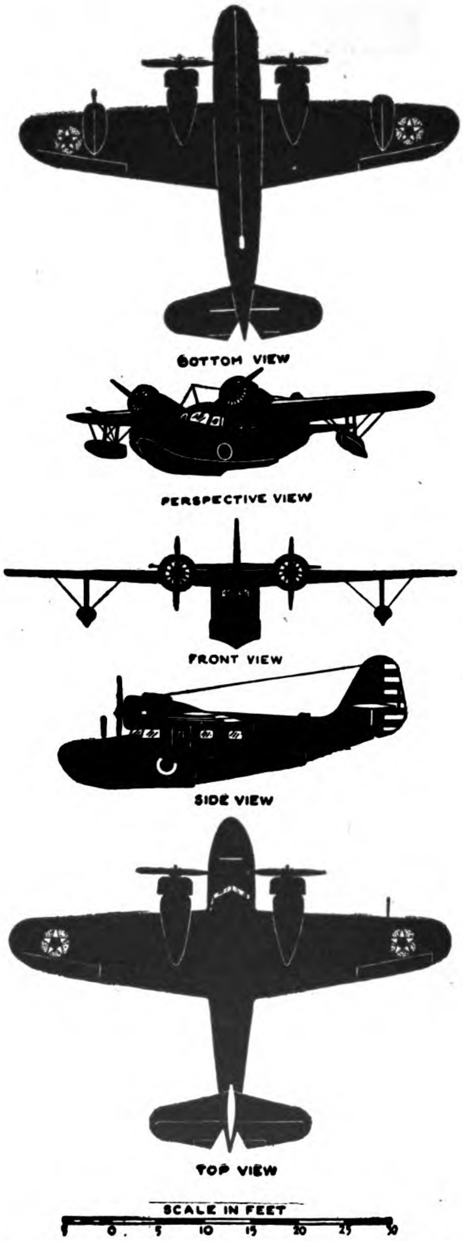


FIGURE 236.—Observation amphibian airplane.

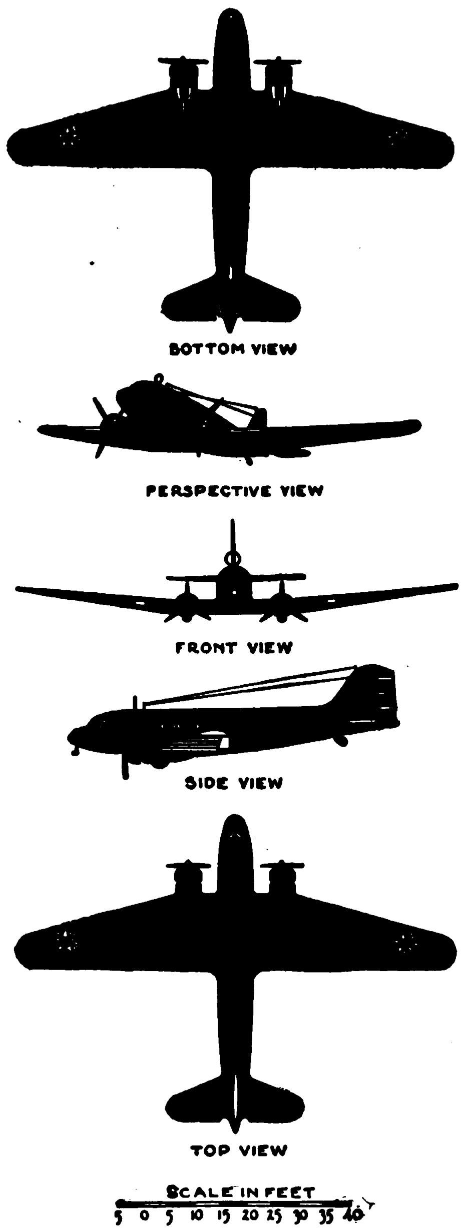


FIGURE 237.—Transport airplane.

SECTION VI

MAP READING

145. Scales, contours, and conventional signs.—*Q*. What is a map? *A*. A map is a picture of an area of ground, which shows certain important features accurately to scale.

Q. Do the features shown on a map appear as they do on the ground? *A.* No. They are represented by symbols called conventional signs, which resemble the actual features as nearly as practicable.

Q. What is a topographical map? *A.* One which (according to its scale) shows all the natural and artificial features of the terrain, such as hills, valleys, streams, woods, roads, towns, houses, bridges.

Q. What is a military map? *A.* A military map is one which shows particularly those features, and conveys that information, which are important for military purposes.

Q. What is meant by map reading? *A.* Map reading is the art of understanding the information given by the map.

Q. What is meant by the scale of a map? *A.* The scale of a map is the relation between any distance shown on the map and the corresponding distance on the ground. It is always the same for any one map.

Q. How is the scale of a map indicated or expressed? *A.*

(1) As a *representative fraction* (*RF*), such as 1/5000 (or 1:5000), which means that any distance on the map is 1/5000 of the corresponding distance on the ground. The RF is always expressed with a numerator of *unity*. The RF is always the ratio of a map distance to the actual or ground distance it represents. Thus if 2 inches (on the map) represent 10 miles on the ground, we can at once express the relation thus:

$$\frac{\text{Map distance}}{\text{ground distance}}=\frac{2 \text{ inches}}{10 \text{ miles}}$$

We must then reduce the numerator and denominator to the same unit, and then reduce the numerator to *unity* to get the RF, as follows:

$$\frac{2 \text{ inches}}{10 \text{ miles}}=\frac{2 \text{ inches}}{10 \text{ miles}\times 5{,}280 \text{ ft.}\times 12 \text{ inches}}$$
$$=\frac{2 \text{ inches}}{633{,}600 \text{ inches}}=\frac{1}{316{,}800}=\text{RF}$$

(2) In *words and figures*, such as 6 inches=1 mile, meaning that 6 inches on the map represent one mile on the ground. From this we can easily get the RF, thus:

$$\frac{6 \text{ inches}}{1 \text{ mile}}=\frac{6 \text{ inches}}{1 \text{ mile}\times 5{,}280 \text{ ft.}\times 12 \text{ inches}}$$
$$=\frac{6 \text{ inches}}{63{,}360 \text{ inches}}=\frac{1}{10{,}560}=\text{RF}$$

(3) By a *graphical scale* drawn on the map, which shows ground distances in their usual units, such as miles, thousands of yards, or

hundreds of feet, as they appear on the map. A graphical scale is easily made if we know the RF of the map. Thus suppose the RF is 1:5000 and we wish a graphical scale to read to 1,000 yards. Since any distance on the map is 1/5000 of the same distance on the ground, 1,000 yards on the map will be as follows:

$$\frac{1000 \text{ yards}}{5{,}000}=\frac{1 \text{ yard}}{5}=0.2 \text{ yard}=0.2 \text{ yard}\times 36 \text{ inches}=7.2 \text{ inches}$$

that is, one 1,000-yard division of our scale will be 7.2 inches long. This can be divided into ten equal parts, each of which will represent 100 yards. (See fig. 240 for examples of graphical scales.)

Q. Why do we have maps of different scales? *A*. The scale of a map must be large enough to show the particular features about which we need information. Thus, a map showing the positions of all buildings and streets in a town must be of much larger scale than a map intended only to show the size and positions of the various counties in a state. A small scale map is one which shows a large area in a small space. Thus 1 inch = 100 miles would be a very small scale map on which very little detail could be shown. A map on a scale of 1 inch = 25 feet would be a very large scale map on which individual trees could be shown in their exact positions. The first map could be used by a general planning a large campaign, the second by an architect laying out a plan of a house and grounds.

Q. What determines the proper scale of a map? *A*. It should be just large enough to show the detail necessary to serve the purpose for which it is to be used.

Q. How do you determine direction on a map? *A*. By referring to an arrow on the map which points due north. It is called the meridian.

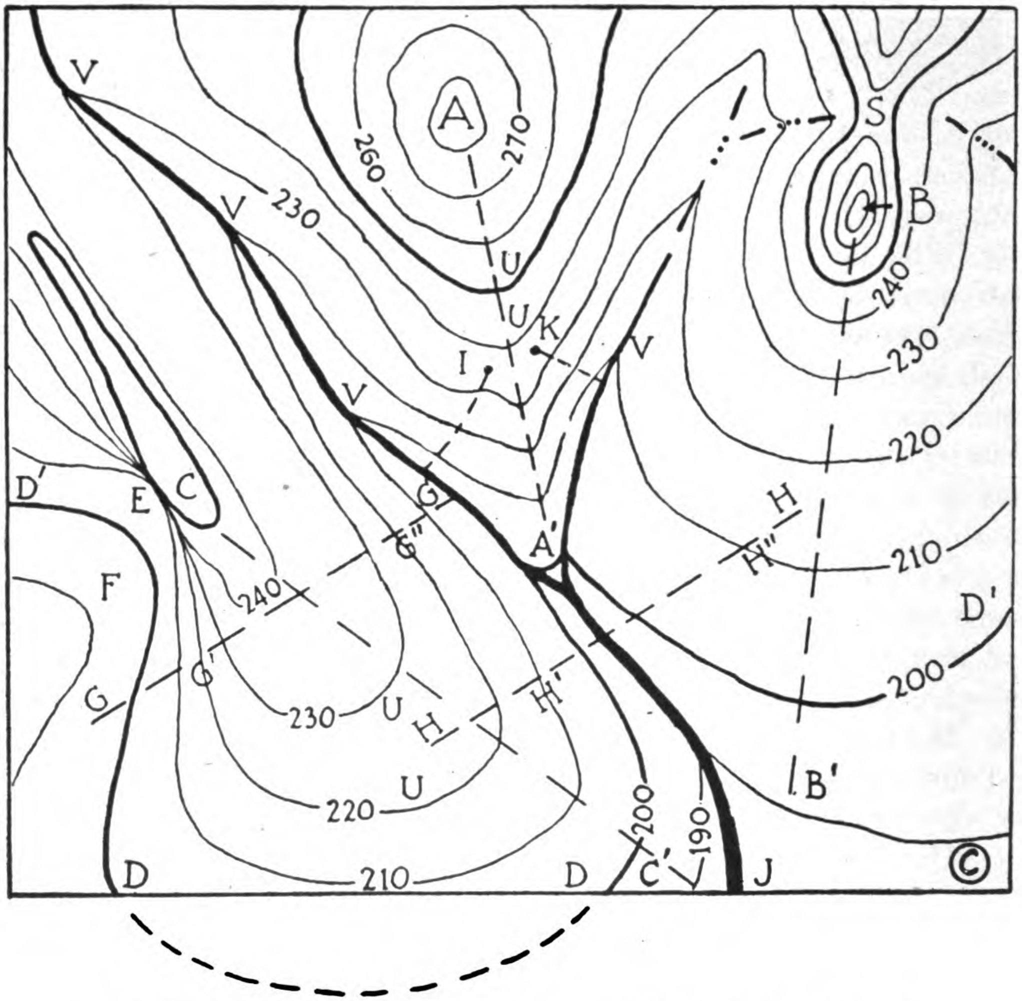
Q. How is direction measured and indicated on a map? *A*. By azimuth as in gunnery. Azimuth on a map is measured from the north point of the meridian, clockwise around the horizon. It is measured in degress, minutes, and seconds, or in mils.

Q. What are the cardinal points of direction, and what are their azimuths? A. North, east, south, and west. Moving clockwise around the horizon: North, the origin, is azimuth 0°; east is azimuth 90°; south is azimuth 180°; west is azimuth 270°.

Q. What is meant by orienting a map? *A*. Placing the map in such a position that the meridian or arrow on the map points to north on the ground. Every line on the map will then be parallel to the line on the ground which it represents, and all the features on the map will be in the same relative positions as the actual objects on the ground.

Q. What is elevation? *A*. The elevation of any point is its vertical height in feet above some level, usually sea level.

Q. How is elevation indicated on a map on a flat piece of paper? *A*. By means of contours.



A, B Hill tops or peaks.
C Ridge.
DD Contours close on themselves.
E Cliff.
AA' Uniform slope.
BB' Concave slope.
CC' Convex slope.
IG Line of steepest slope.
B Steep slope.
B' Gentle slope.
S Saddle.
UU Hill contours.
VV Valley contours.
A' Stream junction.

FIGURE 238.—Typical ground forms as shown by contours.

Q. What is a contour? *A*. An irregular line joining all points at the same elevation. A contour is thus a level or horizontal line.

Q. How are contours separated vertically? *A*. By some definite interval, such as 5, 10, 20, 50, or 100 feet, depending on the scale of the map and the nature of the ground. This constant interval is known as the vertical interval or *contour interval* of the map. Certain contours are numbered with their height (in feet) above sea level.

Q. Do contours show the ground forms, such as hills, valleys, and ridges? *A*. Yes. When one has become familiar with them they show accurately all the forms of nature.

Q. Mention briefly the principal characteristics of contours. *A*.

(1) A contour is a horizontal line joining points of equal elevation.

(2) Contours are spread at uniform vertical intervals.

(3) Every contour is a continuous closed curve. (It may not close within the limits of the map.)

(4) There may be any number of separate contours of the same elevation.

(5) A small, closed contour indicates either a hill top or a depression.

(6) Contours never touch or cross each other except in the case of a vertical or overhanging cliff.

(7) Contours are at right angles to the lines of steepest slope.

(8) The horizontal spacing of contours indicates the degree of slope, steep if they are close together, gentle if they are far apart. They also indicate the kind of slope, uniform, concave, or convex.

(9) Valley contours are usually of V-shape, and hill or ridge contours of U-shape.

(10) Adjacent contours resemble each other.

Q. How is the elevation of a point between two contours determined? *A*. By its relative distance from the contours on either side. Thus in figure 240, the elevation of the number "46" is about 527 feet.

Q. Point out the characteristic ground forms in figure 238 and explain how they are shown by the contours. *A*. See figure 238.

Q. What is a slope? *A*. The inclination of ground to the horizontal. The slope of a road is called its grade.

Q. How can you determine the average grade of a length of road from a contoured map? *A*. Measure the horizontal distance along the road in feet, using the scale of the map. Find from the contours the difference in elevation between the two ends. The difference in elevation of the two ends, divided by the length of the road (both in feet), will give the average grade in percent.

Q. How is a steep grade indicated on a map? *A*. By contours close together, showing a considerable change of elevation in a short distance.

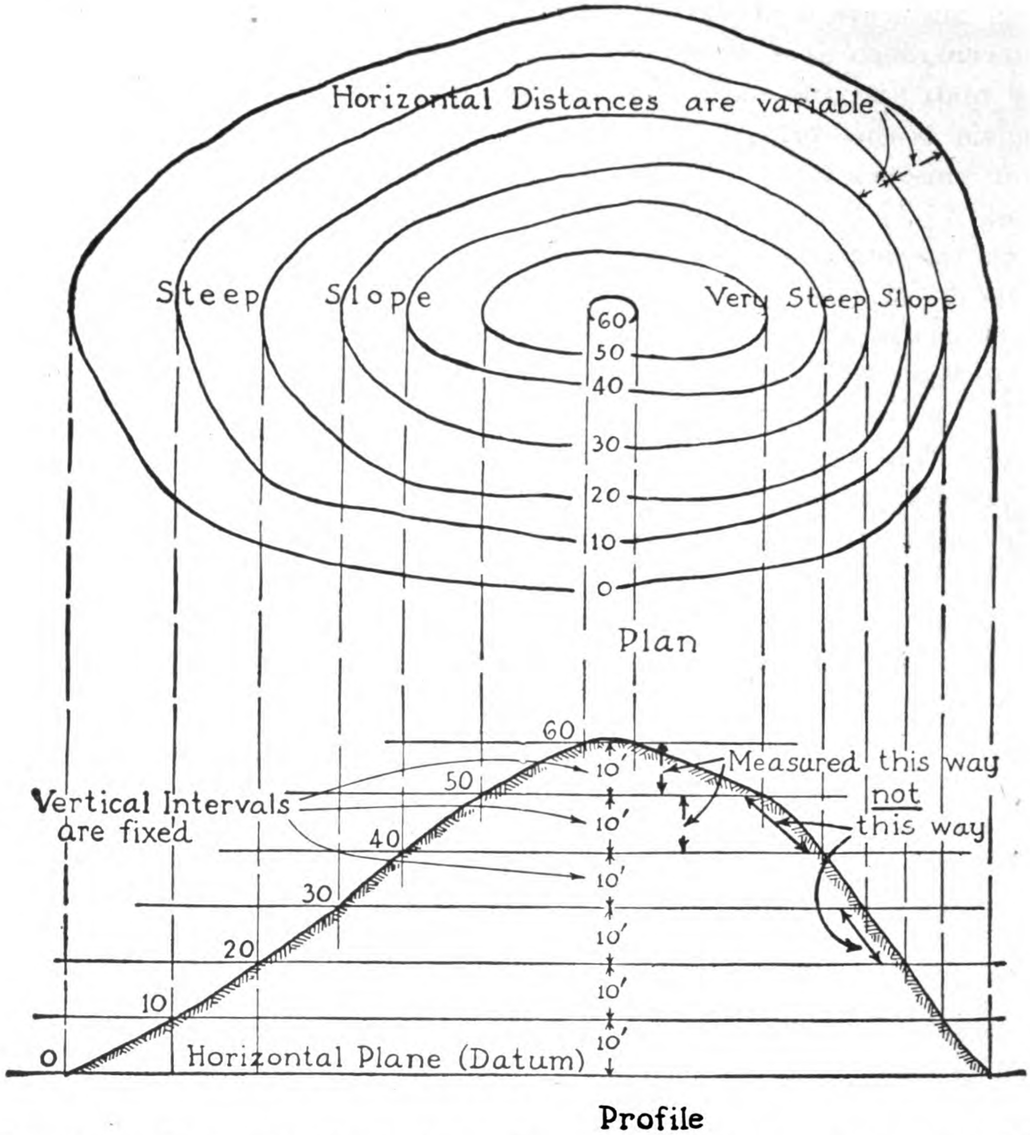


FIGURE 239.—Plan and profile of a hill. (The contours are the lines that would be left on the ground by successive horizontal slices, 10 feet thick.)

Q. What is a profile? *A*. It is a section of the ground as it would appear if it were sliced vertically with a huge knife.

Q. Give a simple method of making a profile. *A*. To make a profile of the hill shown in figure 239, along the line of the words "Steep slope, Very steep slope"; draw a number of parallel lines at uniform intervals, as in the lower figure, numbering them at 10-foot intervals from 0 to 60 feet (the limiting elevations of the hill). Mark each point where a contour cuts the line "Steep slope," and project these points vertically down to the correspondingly numbered lines. Join the points thus found by a line. It will be the contour of the hill on the line "Steep slope."

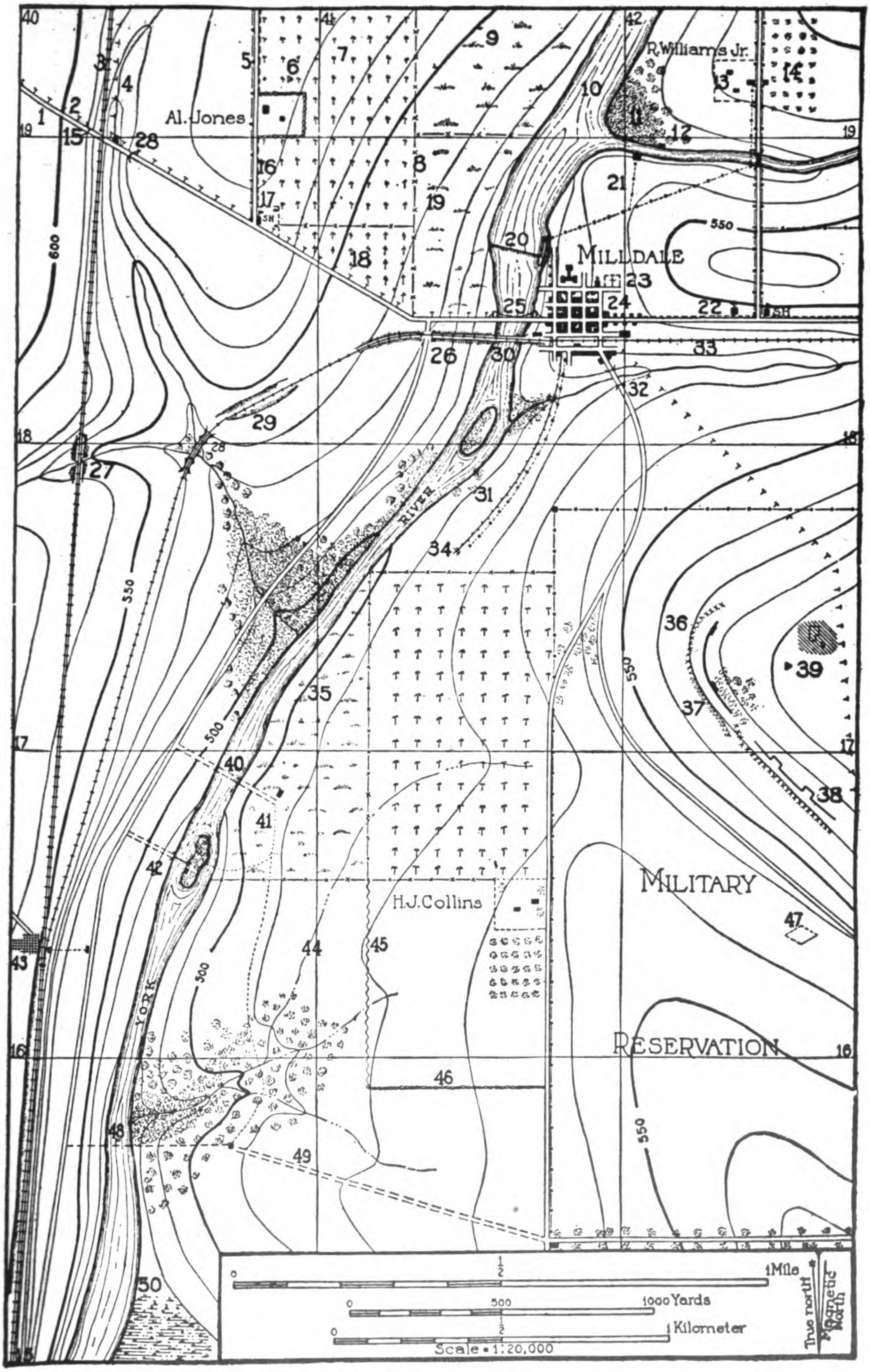


FIGURE 240.—Conventional signs.

Numerical Key

1. Good motor road.
2. Telephone or telegraph line.
3. Double track standard gage railroad.
4. Stream or creek (blue on a 4-color map).
5. Fence, smooth wire.
6. Triangulation point or primary traverse station.
7. Corn field.
8. Fence, barbed wire.
9. Tall tropical grass.
10. River (blue on a 4-color map).
11. Woodland (deciduous trees).
12. Lone trees.
13. Buildings in general.
14. Orchard.
15. Railroad crossings, railroad beneath.
16. Fence of any kind (or board fence).
17. Schoolhouse.
18. Cultivated field, sugar cane.
19. Grassland in general.
20. Dam.
21. Electric power transmission line.
22. Church.
23. Cemetery.
24. City, town, or village.
25. Bridge, suspension.
26. Railroad crossing, railroad above.
27. Fill.
28. Bridge, steel.
29. Cut, railroad.
30. Bridge, truss, for standard gage railroad.
31. Narrow-gage railroad.
32. Bridge, highway.
33. Railroad, single track, standard gage.
34. Mine or quarry of any kind (or open cut).
35. Pasture or grassland in general.
36. Wire entanglement.
37. Low or concealed entanglement.
38. Trenches (dotted when proposed).
39. Demolitions.
40. Ford, general symbol for vehicle ford.
41. Good pack trail or foot path.
42. Bridge, foot.
43. City, town, or village (generalized).
44. Intermittent stream.
45. Worm fence.
46. Stone fence.
47. Tank trap.
48. Equestrian ford.
49. Road, poor motor or private.
50. Marsh in general.

Alphabetical Key

Bridge, foot	42
Bridge, highway	32
Bridge, highway, made of steel	28
Bridge, suspension	25
Bridge, truss	30
Buildings in general	13
Cemetery	23
Church	22
City, town, or village (generalized)	43
Combination showing city, town, or village	24
Crossing, railroad (RR above)	26
Crossing, railroad (RR beneath)	15
Cultivated field, corn	7
Cultivated field, sugar cane	18
Cut	29
Dam	20
Demolitions	39
Electric power transmission line	21
Fence of any kind (or board fence)	16
Fence, barbed wire	8
Fence, smooth wire	5
Fence, stone	46
Fence, worm	45
Fill	27
Ford, equestrian	48
Ford, for vehicles	40
Grassland in general	19
Grass, tall tropical	9
Marsh in general	50
Mine or quarry of any kind (or open cut)	34
Orchard	14
Pasture or grassland in general	35
Railroad, double track, standard gage	3
Railroad, narrow gage	31
Railroad, single track, standard gage	33
River (blue on a 4-color map)	10
Road, good motor	1
Road, poor motor or private	49
Schoolhouse	17
Stream or creek, intermittent	44
Stream or creek (blue on a 4-color map)	4
Tank trap	47
Telephone or telegraph line	2
Trail or foot path	41
Trees, lone	12
Trenches (dotted when proposed)	38
Triangulation point or primary traverse station	6
Wire entanglement (low or concealed)	37
Wire entanglement	36
Woodland (deciduous trees)	11

Q. What are conventional signs? *A*. They are the symbols used by map makers to show the various features of the terrain. As nearly as practicable they resemble or suggest the features they are intended to show.

Q. Point out and name the conventional signs shown in figure 240. *A*. See figure 240.

Q. What colors are used on standard topographical maps and what do these colors mean? *A*. Colors are used to show certain classes of features. On the standard topographical map they show the following:

Black.—All artificial features, such as houses and roads.
Blue.—All water, such as streams, ponds, lakes.
Green.—Vegetation, such as woods and grassland.
Brown.—The ground forms as shown by contours.

146. Location of a position by coordinates.—*Q*. How are military maps divided? *A*. Into squares 1,000 yards on a side by two sets of parallel lines, one of these sets being at right angles to the other. (See fig. 241.)

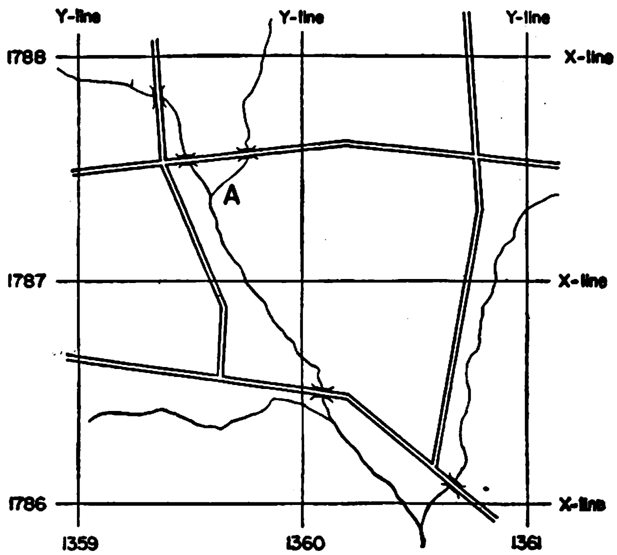


FIGURE 241.—Rectangular coordinates; 1,000-yard grid printed upon a terrain map (1 : 20,000 scale). (Not reproduced to scale.)

Q. What is this system of lines or squares called? *A*. A grid system, or system of rectangular coordinates.

Q. What is the use of this grid or coordinate system? *A*. It is used to make it possible to describe and locate points on a map by referring their positions to the coordinate lines.

Q. What are the coordinate lines running from left to right called? *A*. X lines.

Q. What are the other coordinate lines called? *A*. Y lines.

Q. Describe the grid system for the Continental United States. *A*. The country is divided into zones running north and south, each covering 9° of latitude. The central true meridians of adjacent zones are 8° apart, hence there is an overlap of 1° at the boundaries, included in both adjacent zones. The west longitudes of the central meridians of the zones are 73°, 81°, 89°, 97°, 105°, 113°, and 121°. In each zone the Y lines are all parallel to the central true meridian. The direction of the Y line at any point is called grid north; it is the same as true north only at the center of the zone. The X lines are perpendicular to the Y lines, and so they are true east and west lines only at the center of the zone. In each zone the origin of coordinates, or zero point, is to the west and south of the zone, and hence all coordinates are positive. (See fig. 241.)

Q. What is the X distance or X coordinate of a point on a map? *A*. The distance of that point to the right of the origin of measurement measured along a Y line.

Q. What is the Y distance or Y coordinate of a point on a map? *A*. The distance of that point upward from the origin of measurement along a Y line.

Q. What is the origin or point from which measurements are made? *A*. A point off the map to the west and south. The distance from this origin, in thousands of yards, is indicated on each X line and each Y line.

Q. In order to locate a point on a map, what information is useful?

A. The X and Y coordinates of that point.

Q. In what order are the coordinates of a point always given? *A*. First the X coordinate and then the Y coordinate.

Q. How can their order be remembered easily? *A*. Remember that in the alphabet X comes before Y, or remember the rule READ RIGHT UP.

Q. How can one X line be distinguished from the other X lines or one Y line from the other Y lines? *A*. Each set of lines is numbered.

Q. How are the X lines numbered? *A*. In the left and right hand margins, increasing upwards from the bottom of the map.

Q. How are the Y lines numbered? *A*. Along the upper and lower margins, increasing from left to right of the map.

Q. Is the number of a coordinate line given in the margin of a map the full number of that line? *A*. No. It is only a part of its full number.

Q. Are there any coordinate lines on a map that have their full numbers given? *A*. Yes. The first X line at the bottom of the map and the first Y line at the left of the map.

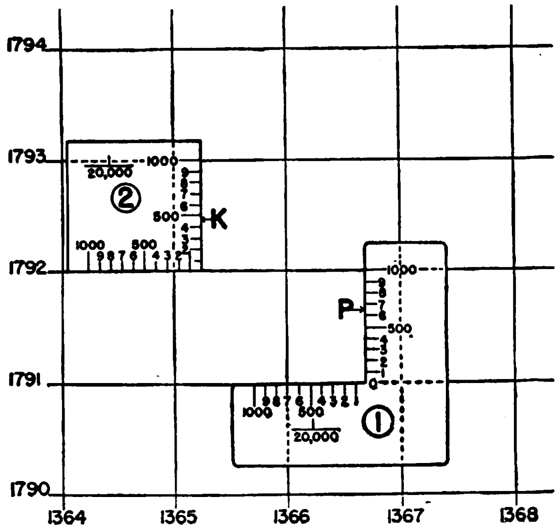


FIGURE 242.—To plot position of point with coordinate scale on terrain map (1 : 20,000 scale) having a 1,000-yard grid. (Not reproduced to scale.)

Q. Explain in detail how to read the coordinates of any point on a gridded map. *A*. The coordinates of any square in the grid system are the X and Y coordinates of the lower left hand (southwest) corner of the square. The coordinates of the lower left hand square in figure 242 are (1,364,000–1,790,000) but are usually written (1364–1790), it being understood that each number represents thousands of yards. These coordinates also locate to the nearest thousand yards any point in the lower left hand square of figure 242. To locate a point more closely we can assume that each side of the square in question is divided into 10 equal parts, each of which represents 100 yards. Then the coordinates of the center of the lower left hand square would be expressed as (1364.5–1790.5), which locates the center to the nearest hundred yards in each direction. The method may be further refined to read to the nearest 10 yards.

Q. What is a coordinate scale? Explain its use. *A*. A coordinate scale is a right-angled ruler made of thin metal, celluloid, or other material with scales on it equal in length to the grid interval of the map being used (fig. 242). To plot any point on the map, for instance the Point P of which the coordinates are given as (66.70–91.65), place the coordinate scale on the map in position ① as shown in figure 242. The position of P can be marked at once with a pin or sharp pencil. It should be noted here that the first two numbers of the coordinate expression (1366.70–1791.65)

have been dropped because they are common to all points in the section of map under consideration. The process of reading the coordinates of a point appearing on the map is the reverse of the method given for plotting a point on the map.

Q. How many norths are indicated on an artillery map? *A*. Three. True north, magnetic north, and grid north. (See fig. 240.)

Q. Define each. *A*.

(1) True north is geographic north, or the direction of the north pole.

(2) Magnetic north is the direction in which the compass points when used in the area covered by the map. The angular difference between true north and magnetic north is called the magnetic declination.

(3) Grid north is the direction in which the Y-lines of the coordinate system point.

Q. When indicating direction which north is generally used? *A*. Grid north.

Q. On what kind of maps is such a system of coordinates usually found? *A*. On topographical maps.

Q. What type of maps are often used to cover harbors and water areas? *A*. Coast and Geodetic Survey maps.

Q. Do these maps generally have a system of grid coordinates? *A*. No. There is, however, a local system of grid coordinates placed on these maps so points can be located in the same way.

Q. What do these maps show? *A*. Coast line, channels, depths of water, location of lights, channel markers, and certain permanent features of the terrain along the shore.

(In addition the candidate should be required to give the coordinates of several points on a map.)

147. Following a route indicated on a map.—*Q*. How is a route, selected from a map, usually indicated? *A*. It is indicated by naming successive points along the route that can easily be identified locally.

Q. How are the best roads identified on the ground? *A*. Usually they will be paved, and will be wider, straighter, and have easier grades than secondary roads. If not paved, they will at least be wide and show signs of traffic. They usually have telegraph or telephone lines running parallel to them. Except in very sparsely settled country the principal roads will also be indicated by sign-posts at intersections and Federal and State numbers, which are shown on commercial route maps.

Q. What points along a route are most easily identified? *A*.

(1) Large towns.

(2) Villages.
(3) Important crossroads or junctions.
(4) Crossings of large streams.
(5) Railroad crossings.
(6) Crests of important hills or ridges.
(7) Passes or gaps through lines of hills.

Q. How may an indicated route be traced on a map? *A*. By locating in succession the towns, crossroads, and other important points named.

Q. How are crossroads and road junctions indicated on a map? *A*. By numbers sometimes followed by a letter as 423 or 423–A.

Q. How would crossroad 418–A be written in indicating a route? Road junction 403? *A*. CR 418–A. RJ 403.

Q. To what do the numbers in the previous answer refer? *A*. To the elevation of the crossroad or road junction.

Q. In case a crossroad or junction is not plainly marked on the map, how would it be indicated? *A*. By its coordinates, as CR (4365.5–6427.3) or RJ (7295.4–8665.4).

(The candidate should be able to trace out on a map a route that has been indicated to him.)

148. Data as to roads, bridges, fords, grades, and swamps.—*Q*. What information concerning a road can usually be obtained from a good topographical map? *A*.

(1) The distance between any two points.

(2) Whether or not the road is paved, and often the kind of pavement.

(3) The width of the road, that is whether narrow, wide, or quite wide.

(4) The steepness and length of important grades.

(5) The stream crossings, whether bridges, fords, or ferries, and sometimes the kind and principal dimensions of bridges; width, depth, nature of bottom, and velocity of current in the case of fords; and the kind of ferry.

Q. What is usually the most critical question in the selection of a route? *A*. The stream crossings.

Q. How would you decide the question as to whether a certain bridge was safe for the transport accompanying your organization. *A*. Reports on the practicability of all bridges should be secured in advance if possible. If not, the following observations will indicate the safety of bridges in most cases.

(1) Bridges on important routes habitually carry heavy commercial trucks and buses, moving at high speed, and are therefore safe for artillery transport moving slowly.

(2) If a bridge is massive, and reasonably new, or apparently in good condition as to flooring, paint, etc., it is probably safe.

(3) Bridges may be compared with similar bridges that have been crossed. If they look too light or appear to be of older design than other bridges, they should be regarded with suspicion.

(4) If there is any chance that the enemy may have tampered with a bridge, its abutments, piers, flooring, and truss members or cables should be examined to make sure they are intact.

(5) If in doubt about any bridge, send across some lighter vehicle and watch the bridge as it crosses. If there is no excessive sway or vibration the bridge is probably safe for the next heavier load. Send loads across one at a time and at very slow speed.

Q. How may the practicability of a ford be determined? *A.* Note the swiftness of the current. Send a line of men to wade across, preferably barefoot, to determine the depths, nature of the bottom, and whether the banks are steep or slippery or both. Some of the lighter vehicles may then be sent across, and these can assist the heavier vehicles by pulling them out on the far side if necessary.

Q. In case a bridge or ford proves impassable what should be done? *A.* Detour to another crossing.

Q. What in general can you say as to the practicability of routes? *A.* That in general important main routes are practicable for artillery transport; that in the case of less important routes it is desirable to have a reconnaissance made in advance by competent experts; that any route that lacks a bridge at an important crossing is of doubtful practicability.

(The candidate should be required to examine a route shown on a map, to give all the information concerning it that can be obtained from the map, and his opinion as to the practicability of the route.)

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[A. G. 062.11 (9-20-41).]

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(For explanation of symbols see FM 21-6.)

U. S. GOVERNMENT PRINTING OFFICE: 1942

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OUT OF ACTION	MARCH ORDER

ection

CHANGE TARGET	IN ACTION
Repeats or gives command. Causes sound locator crew to point locator in direction of new target. If new target is not already illuminated, causes personnel to search for and pick up target in	Repeats or gives cor voice or signal. Co supervise locator crew track target. Looks for reports illumination or searchlight commander.

Details	OUT OF ACTION	MARCH ORDER
Light comm	Commands or signals by buzzer: OUT, to the light. Causes crew to assume "stand by" status.	Ascertains the conditions of movement of the unit. Commands: MARCH ORDER. Supervises the picking up and stowing of equipment. Checks to see that hold-down devices are fastened in the truck prior to taking the road.
No. 1 (azi controller).	Stands by for further orders.	Assisted by No. 4 knocks down control station and packs it on truck. Disconnects telephone and places it on truck. Places red cable reel on rear of truck and reels in cable. Assists in loading searchlight on truck. Verifies that controller is properly fastened by hold-down devices.
No. 2 (ligh ator).	Opens main arc switch upon signal or command. Stands by ready to close main switch on command or signal.	Disconnects cables at the light. Secures light in traveling position. Assisted by Nos. 1, 3, and 4, loads light on truck. Verifies that light has been properly fastened by hold-down devices. Assisted by No. 1, moves yellow reels to rear of truck and reels in cables. Disconnects telephone at the light and places it on truck. Places extended hand control on truck.
No. 3 (pow operator).	Continues as at "stand by," checking that voltage is at proper no load-value.	Disconnects power cables at the power plant. Secures the power plant for traveling. Enters in log hours run.
No. 4 (cha	Stands by for further orders.	Drives truck to control station. Assists No. 1 in knocking down and stowing control station equipment. Drives truck to searchlight and assists in loading the light. Drives truck to power plant and picks up power plant. Receives instructions from the light commander relative to the movement of the unit.

[1] In ma